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DRAFT ENVIRONMENTAL IMPACT STATEMENT ON • • • •

CLYDE PARK — DILLON 161 KILOVOLT AND 69 KILOVOLT TRANSMISSION LINES

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DRAFT ENVIRONMENTAL IMPACT STATEMENT ON

THE PROPOSED MONTANA POWER COMPANY CLYDE PARK-DILLON 161 KILOVOLT AND 69 KILOVOLT TRANSMISSION LINES

ENERGY PLANNING DIVISION
ALBERT C. TSAO, ADMINISTRATOR
DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
GARY J. WICKS, DIRECTOR

JANUARY 1976

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CHAPTER ONE

Introduction

Prior to the construction and operation of certain utility facilities within the State of Montana, an application must be made to the Department of Natural Resources and Conservation (Department or DNRC) for a Certificate of Environmental Compatability and Public Need. Applications made before April 23, 1975, were filed in conformance with the Montana Utility Siting Act of 1973 (effective April 23, 1975, the Act was revised and renamed the Montana Major Facility Siting Act). The Siting Act recognizes that the construction of additional power facilities may be necessary to meet an increasing need for electricity. However, it also recognizes that the environmental life support system and natural resources of an area may be adversely affected if such facilities are built without regard to their protection or degradation. Facilities which require a Certificate are identified in the Utility Siting Act as follows:

(1) any energy-generating and conversion plant and associated facilities designed for, or capable of:

   (a) generating at fifty (50) megawatts of electricity or more

   (b) producing one hundred million (100,000,000) cubic feet of gas per day or more

   (c) producing fifty thousand (50,000) barrels of liquid hydrocarbon products per day or more

   (d) enriching uranium minerals

(2) an electric transmission line and associated facilities of a design capacity of thirty-four and one-half (34.5) kilovolts or more, with the following exceptions:

   (a) a transmission line and associated facilities with a design capacity of sixty-nine (69) kilovolts or less constructed above ground for a distance of ten (10) miles or less shall not be considered a utility facility

   (b) a transmission line and associated facilities with a design capacity of one hundred sixty-one (161) kilovolts or less constructed underground for a distance of five (5) miles or less shall not be considered a utility facility

(3) a gas or liquid transmission line and associated facilities designed for, or capable of, transporting gas or liquid hydrocarbon products from a gasification or liquefaction facility of the size indicated in (1) (b) and (1) (c) above

(4) any use of geothermal resources, including the use of underground space in existence or to be created, for the creation, use or conversion of energy

An application for the construction of a facility as specified above shall be made two years before the expected commencement of construction. The Department is then responsible for preparation of an environmental impact statement, a compilation of intensive studies conducted to determine possible adverse impacts to aspects of the natural (i.e., geology, soil, vegetation, fauna) and cultural (i.e., land use, economy, sociology, aesthetics) environments if a facility is constructed as proposed by the applicant. Within six hundred (600) days following receipt of an application, the Department recommends to the Board of Natural Resources and Conservation whether the proposed facility should be certified. The final decision rests with the Board.

Within this chapter, general information can be found relating to the application and the pursuant amendment filed for the Clyde Park-Dillon transmission line project. An unpublished Technical Appendix containing detailed technical material on certain of the subjects presented in this study is available for review at the Department; specific material available is referred to in the text.

1.1. Date of Filing Application

Applicant, General Content

In accordance with the Montana Utility Siting Act, an application was filed by Montana Power Company with the Department on June 6, 1974, for permission to construct an electric transmission line facility between Clyde Park and Dillon. The purpose of the proposed facility is to meet increasing electrical loads in areas of Montana located in Park, Gallatin, Madison, and Beaverhead Counties, including particular areas in and around Gardiner, Yellowstone Park, and Big Sky.

The proposed facility would consist of 155 miles of 161-kV electric transmission line extending from Clyde Park to a substation in the Upper Yellowstone Valley, continuing on to Big Sky, and then to the Dillon-Salmon Substation. The facility would consist also of approximately 17 miles of 69-kV electric transmission line extending from the substation in the Upper Yellowstone Valley to Gardiner.

The 161-kV line would be constructed on double pole "H" frame structures, and the 69-kV line would be constructed on single poles of varying heights, depending upon location and terrain conditions.

1.2. Date of Filing Amendment

General Content

In accordance with the Montana Utility Siting Act of 1973, Montana Power Company filed an application on June 30, 1975, to amend its application for a Certificate of Environmental Compatability and Public Need for the Clyde Park to Dillon transmission line facility. In its application for an amendment, the applicant states that:

> A portion of the preferred corridor of applicant, as set forth in the original application, is located in the Porcupine-Buffalo Horn area west of Tom Miner Basin. Subsequent to said filing of June 6, 1974, parts of this area have been designated as a candidate wilderness area.
>
> In an effort to accommodate the land use and environmental planning for the Porcupine-Buffalo Horn area, while still meeting the electric needs of the areas to be served by this facility, the applicant contacted the Department of Natural Resources regarding proposed changes to its original application on file herein.

The applicant's statement identifying the Hyalite-Porcupine-Buffalo Horn area as a candidate wilderness area is not entirely accurate. The area is actually a U.S. Forest Service "new study area," one of many being studied for possible wilderness status in the future.

In order to avoid the Hyalite-Porcupine-Buffalo Horn area, the applicant has requested that its original application be amended to exclude the Miner to Big Sky line and to include the Ennis to Bozeman 161-kV transmission line, and that the following transmission lines be treated as one project (for locations of lines, see map entitled "Applicant's Requested Routes"):

Clyde Park-Bozeman 161-kV line
Clyde Park-Emigrant 161-kV line
Dillon-Big Sky 161-kV line
Bozeman-Ennis 161-kV line
Emigrant-Gardiner 69-kV line

The amendment further deletes the reference to 155 miles of 161-kV transmission line, and adds the following lengths of line and locations:

(1) Approximately 39 miles of 161-kV line between Clyde Park and Emigrant

(2) Approximately 72 miles of 161-kV line between Dillon and Big Sky

(3) Approximately 52 miles of 161-kV line between Bozeman and Ennis

(4) Approximately 25 miles of 69-kV line between Emigrant and Gardiner

As a result of the application for an amendment, the applicant and the Department entered into a written agreement dated May 30, 1975, in which the following agreements were made:

(1) The Department will treat all the following transmission lines as one project:

  (a) Clyde Park-Bozeman 161-kV "B" line

  (b) Clyde Park-Emigrant 161-kV line

  (c) Dillon-Big Sky 161-kV line

  (d) Ennis-Bozeman 161-kV line--(for which the applicant would submit all data required by the Utility Siting Act and the rules and regulations thereunder to the Department at the earliest date possible, but not later than July 1, 1975)

  (e) Emigrant-Gardiner 69-kV line

(2) The Department's report to the Board of Natural Resources and Conservation shall be made on or before April 1, 1976 (an extension of two months due to changes in the study incurred by the amendment)

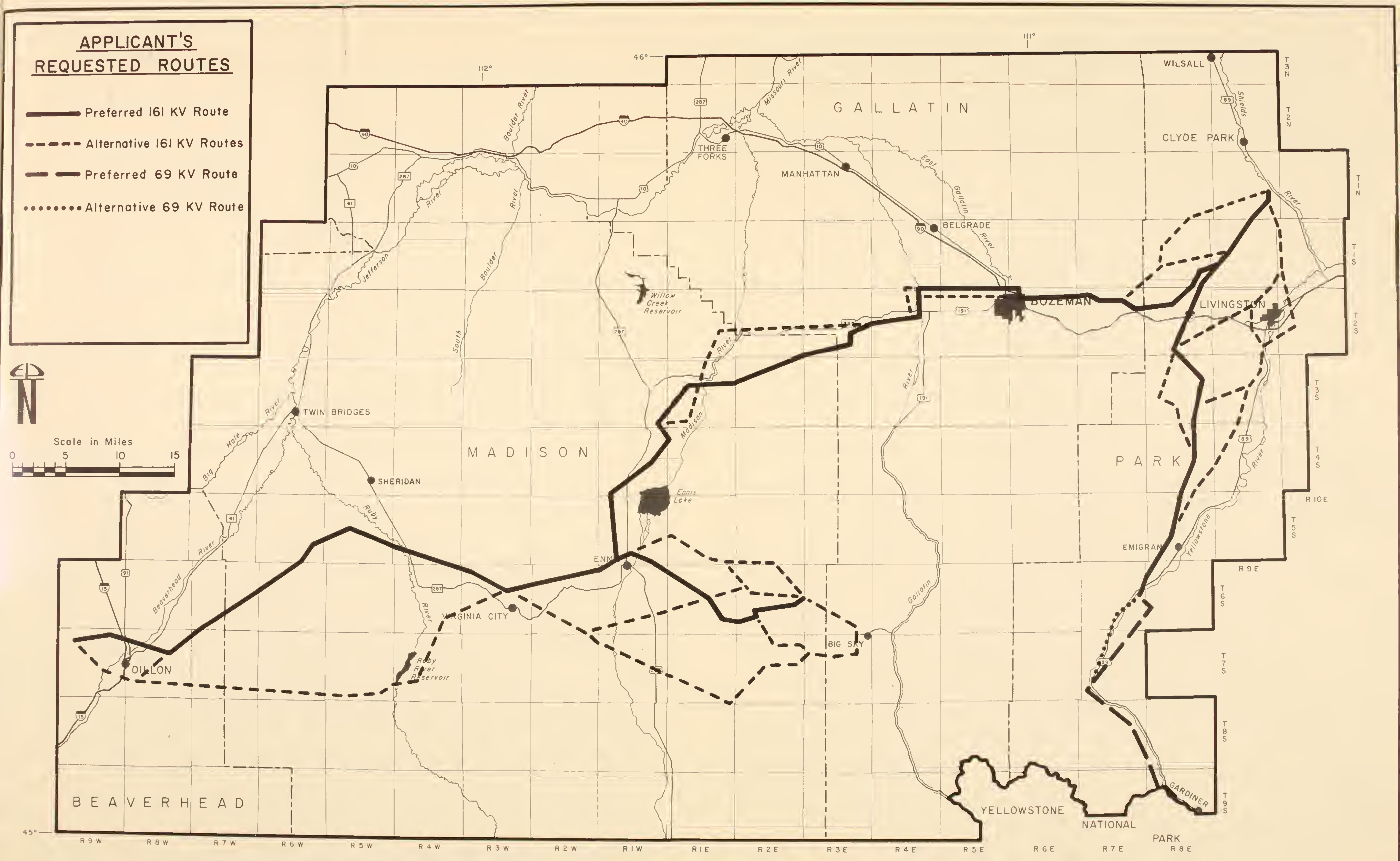
(3) The Montana Power Company agreed to pay the Department $5,000 for the extra work involved in any changes made as a result of the amendment

1.3. U.S. Forest Service Role

The U.S. Forest Service has strongly supported the Department in the preparation of this environmental impact statement. Wherever national forest land is involved in the study area, the U.S. Forest Service has provided basic information available on specific geographical locations. For example, Forest Service maps were used in the mapping of specially-managed areas, big game animal distributions, and existing land use. Information was also provided for the vegetation inventory, and stream and lake survey fishery data was given for the aquatic fauna inventory. In addition to the personnal support of data gathering, the Forest Service provided $10,780 in order for the Department to contract with a consulting firm to gather the basic vegetation information of the Forest Service land involved.

1.4. Corridor Selection Process

The computerized corridor selection process employed by the Department in this project is an experimental approach. It is a rather new method, and the entire process is discussed in detail in Chapter Two, and in Chapter Six, section 6.4.



CLYDE PARK—DILLON 161 KV TRANSMISSION LINE PROJECT **ENERGY PLANNING DIVISION, DNR & C 1976**

CHAPTER TWO

Methodology

2.1. Introduction

The method of transmission corridor study used in this project employs a systematic planning process to meet the decision-making requirement. The accompanying diagram (Figure 2-1) entitled "Transmission Corridor Study Methodology," offers an overview of the approach. Six processes are used, as shown in the diagram. These are: (1) load and reliability analysis, (2) utilization or expansion of existing systems to accommodate the need, (3) determination of electricity sources and terminals (i.e., system alternatives), (4) transmission technology selection, (5) transmission corridor selection, and (6) impact evaluation. This methodology provides a measure of organizing and simultaneously directing and executing a complex series of separate, but interrelated, social, economic, environmental, and engineering studies. Due to the dynamic nature of the methodology, some processes are conducted in hierarchal order while others are carried out concurrently in order to improve efficiency. Certain processes are conducted in hierarchal order because the results of prior processes will dominate the research direction of following processes. The initiation and study of a given process without the result of the previous process may result in wasted work or erroneous findings. Further explanation of each process follows.

2.2. Load and Reliability Analysis

In general, need for a transmission line arises if one or both of the following needs exist:

(1) To supply load growth requirement. The conventional method of studying load growth is based on the historical growth rate of an area with an adjustment made to incorporate known facts that are likely to affect future growth.

(2) To increase reliability. If an existing transmission system cannot absorb certain degrees of line outage or voltage drop, more line(s) may be needed.

2.3. Utilization or Expansion of Existing Systems to Accommodate the Need

If the need is established, the next step is to decide upon measures to serve the need. Prior to constructing a new transmission line, the

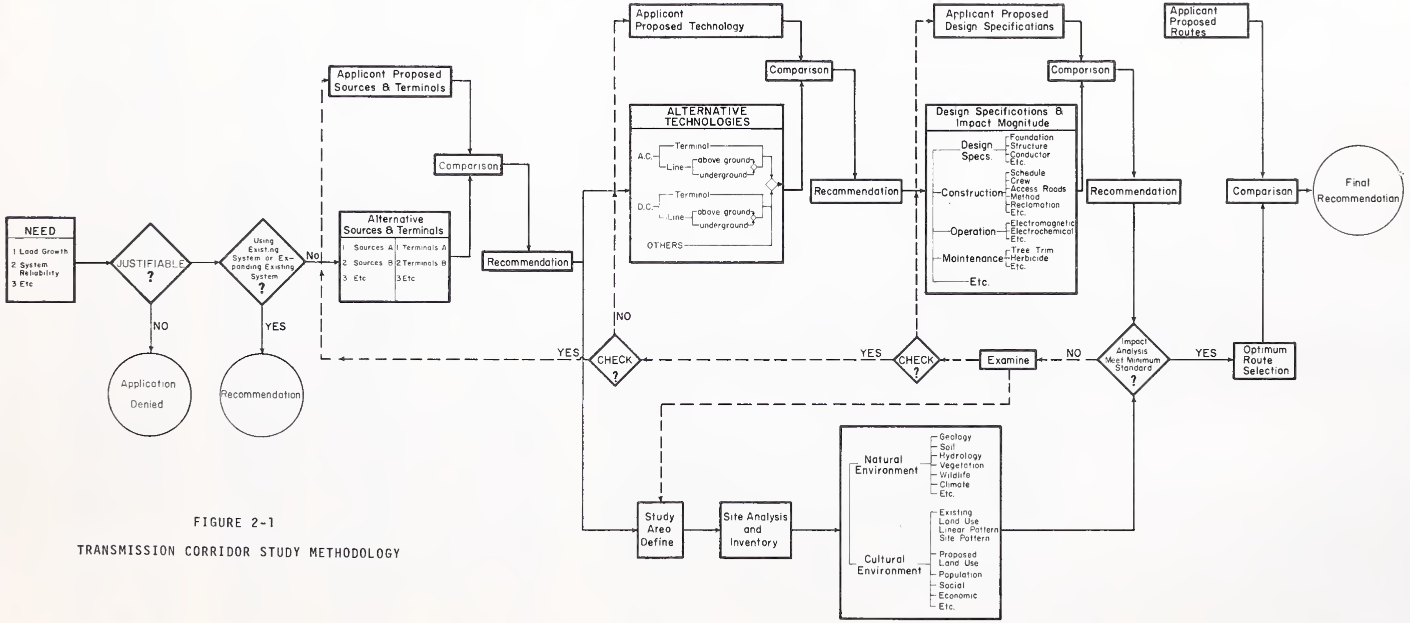


FIGURE 2-1

TRANSMISSION CORRIDOR STUDY METHODOLOGY

existing system is examined in order to conclude whether it can be expanded to accommodate the need. Examples of ways to expand the existing system include replacing conductors and replacing both tower or pole structures and conductors. The latter, in some cases, might require widening of the right-of-way.

2.4. Determination of Electricity Sources and Terminals (i.e., System Alternatives)

If expansion of the existing system is not feasible, construction of a new transmission line is necessary. Therefore, alternative electricity sources, terminals, and intermediate terminals (if any) must be established, and a comparison made based on installation cost, engineering, and environmental impacts (including natural, land use, social and economic elements) in order to select an optimum source and terminals.

Intermediate terminals, in general, are used to: (1) supply further load growth of an intermediate-terminal-related area, or (2) increase the reliability of the intermediate-terminal-located area.

Without determining the optimum source and terminal, the next process of defining the study area and conducting the environmental inventory may later be void. This and all successive steps can be grouped into two major categories: engineering design-related and environment-related. All engineering steps are intimately related and affected by each other. Any change made within a step may trigger a change of design for all the other steps. For example, a change of electricity source may result in using a lower kV line rather than the proposed one. Also, close interrelationships exist between engineering and environmental steps. For example, in order to minimize the impacts on the environment to meet certain required standards, certain engineering design features may have to be changed. On the other hand, a change in engineering design specifications may involve different impacts on the environment. As a result of these inter- and intra-relationships, checkback loops are employed in the methodology to ensure that all the relationships are considered. Only the most important loops are indicated on the diagram.

2.5. Transmission Technology Selection

After the electricity source and terminals have been determined, two series of steps, one engineering-related and the other environment-related, can be conducted concurrently.

Various transmission technologies include various voltages of A.C. and D.C., and above-ground and underground transmission. Conventionally, the selection of technology has been based solely on the installation cost. D.C. lines are used for long distance, direct transmission of large amounts of power without any intermediate terminals. Underground transmission is only applied to lower voltage lines. Comparisons are made based on factors of installation cost, engineering, and impacts on the environment in order to select an optimum technology.

2.6. Transmission Corridor Selection

The transmission corridor is selected based upon the following subprocesses:

1) Definition of the study area. A geographic area large enough to include all reasonable routes for the proposed lines between Clyde Park and Dillon is chosen for the study area, shown on Figure 2-2.

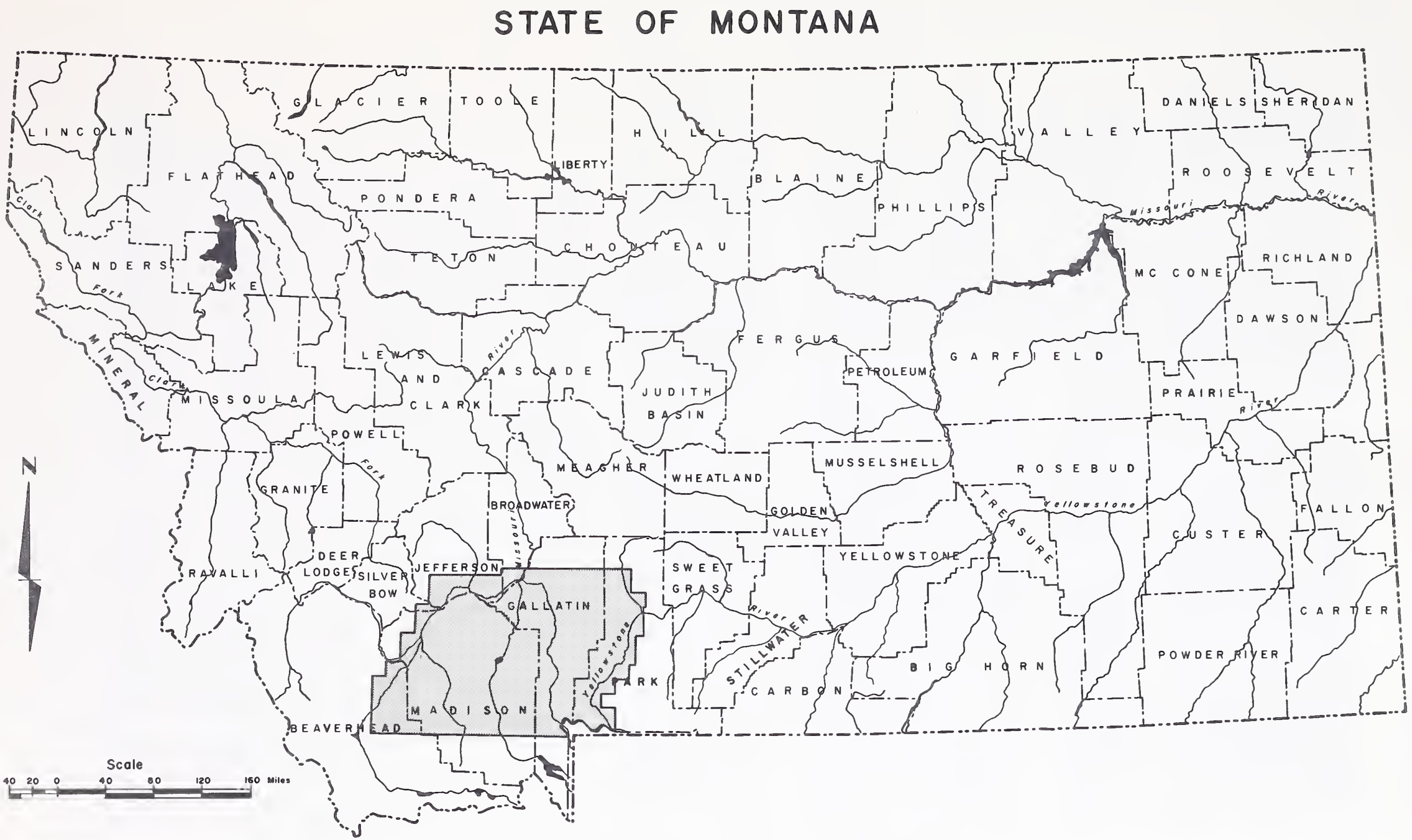
2) Determination and analysis of engineering design criteria/specifications and impact magnitude. Transmission line characteristics that are considered for corridor selection are: various construction methods and related impact magnitudes, physical presence of the lines, operational characteristics and impact magnitude, and maintenance.

3) Identification of concerns. Criteria or concerns used for corridor selection vary from region to region depending upon the characteristics of the natural and cultural environments of the study area. A set of criteria has been generated for the study of the proposed line as follows. An optimum transmission corridor shall have:

    1. Least risk for stream sedimentation
    2. Least impact on biomass productivity on rangeland
    3. Least impact on biomass (wood) productivity in forest land
    4. Least impact on terrestrial fauna
    5. Least cost of construction and maintenance
    6. Greatest reliability
    7. Least impact on existing land use
    8. Least visual impact

    During the process of identifying concerns, it is essential to make sure that the magnitude of each one stays at relatively the same scale, i.e., scale homogeneity exists between criteria identified. Possible overlap between the content of each concern should be avoided.

    An optimum corridor usually can be generated to fulfill each environmental problem. However, due to the conflicting nature of some problems, an optimum corridor for one may be unacceptable for another. "Trade-offs" between concerns will be discussed later.



CLYDE PARK–DILLON 161 KV STUDY AREA

Figure 2-2

4) Identification of environmental elements that shall be used for optimum corridor selection for each concern. A set of environmental elements is needed in order to select a corridor that will fulfill the requirement of each concern. For example, to define a corridor with least impact on the wildlife system, determination of wildlife habitat by species and key areas, including wintering ground, migration routes, etc., should be made. This is a lengthy and continuous process.

   Environmental elements for this application related to each concern described in the above subsection are listed in the matrix in Chapter Six, section 6.4.

5) Site analysis, inventory and computer mapping. Typical methods of inventorying environmental elements include searching for existing available data, remote sensing interpretation, and field surveys. Detailed inventory of each environmental element is provided in Chapter Six.

   After data inventory, the data is stored in digital format for efficient data retrieval and manipulation. Further discussion of computer mapping and data manipulation will be given in Chapter Six, section 6.4.

6) Matrix formation, rating, and optimum corridor selection for each concern. To select an optimum corridor for each concern, related environmental elements are compared to each other on the basis of suitability for corridor location. Then a rating system is used to define the various categories of comparative suitability. The rating system used for this study is:

   0 - No relationship in the model (i.e., it is assumed where no numerical value is given in the matrix). Zero does not mean zero impact.

   1 - Little or no impact or constraint in the model in which it is being used.

   2 - Small but significant impact or constraint.

   3 - Moderate impact or constraint.

   4 - Large impact or constraint.

   5 - Severe impact or constraint (which includes absolute exclusion, such as crossing wilderness areas or national parks).

   Detailed discussion on matrix formation, rating, and optimum corridor selection for this application is given in Chapter Six, section 6.4.

7) Final corridor selection. Final corridor selection results from comparisons made between concerns. These comparisons involve different issues. Certain criteria contain dollar values only, while some imply quantifiable values, and others relate to abstract values. In general, no single corridor can minimize all impacts, but the possibility of finding one should not be ruled out. Therefore, in the first comparison, all unsuitable values of all concerns should be combined, and a possible corridor may be revealed. Otherwise, greater subjectivity must be employed, although certain guidelines for minimizing impacts can be used. Therefore, various patterns of comparison between concerns ought to be tested in order to obtain a final corridor.

2.7. Impact Evaluation

After the corridor selection is finalized, possible impact of the selected corridor will be evaluated. Impact magnitude comparisons will be made between the selected corridor and the applicant's preferred corridor. Mitigating measures will be recommended in order to minimize the environmental impacts.

CHAPTER THREE

The Need

3.1. Introduction

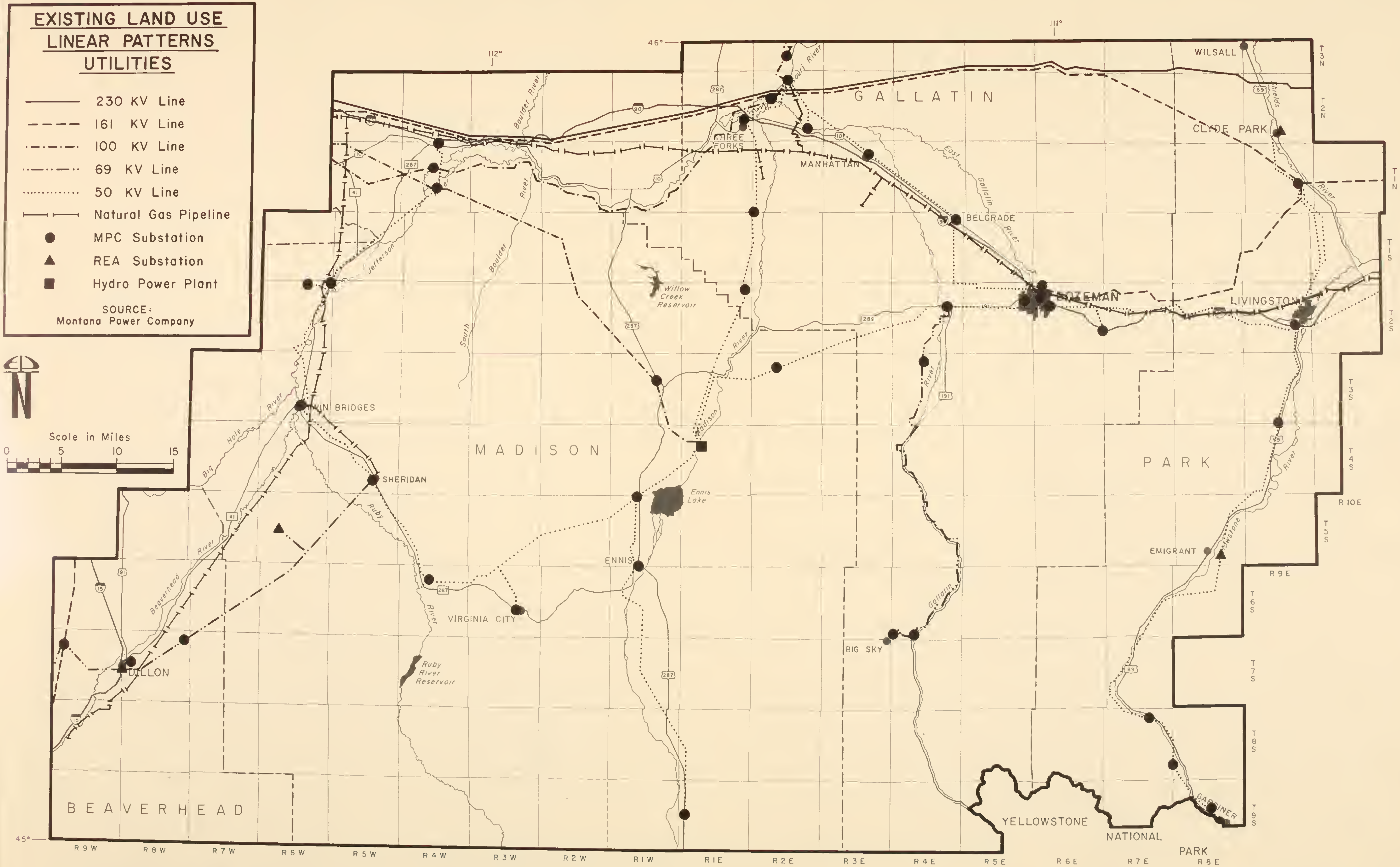
The purpose of this chapter is to address the question of need as related to the proposed transmission line project. As discussed in Chapter Two, a transmission line may be needed to meet an electrical load growth of an area, or to increase reliability of a transmission system. The applicant anticipates an increased electrical load within the study area. Section 3.2. examines some of the reasons behind the load growth trend. Section 3.3. discusses system reliability and problem service areas. Problem service areas are: Big Sky, Bozeman, and the Upper Yellowstone Valley and Yellowstone National Park. Several tables have been included within this chapter on population change, demographics, and technical data related to transmission lines.

To ascertain a need for additional electricity, it is necessary to examine the existing electrical transmission system within the study area. A map in this section entitled "Existing Land Use-Linear Pattern/Utilities," delineates existing transmission lines within the study area. In addition, Table 3-1 provides detailed information relating to existing lines: the year of construction, length, voltage level, present load, and maximum load carrying capacity.

Determination of maximum load carrying capacity, and, thus, the ability of the existing system to provide additional electricity, involves many variables. Some of them are: compensating equipment at the end of the line, the nature of the electrical load, sending end voltage of the line, interconnection with other lines, and outage in the interconnection system. Consideration of all these variables requires a detailed engineering study known as a "load flow study." Section 3.3. will discuss such a study.

3.2. Need Analysis

Factors which affect electrical load growth are variable and sometimes unforeseen. They include not only population growth, but also changing habits (i.e., increased use of electricity by individuals), and recreational development. In specifying a need for the proposed facilities, the applicant has cited electrical load growth at Big Sky, Bozeman, and the Upper Yellowstone Valley, all of which are discussed separately below. For this study, the major load growth will be created by the development of the applicant's requested all-electric Big Sky resort, primarily a second home recreational development.



CLYDE PARK—DILLON 161 KV TRANSMISSION LINE PROJECT ENERGY PLANNING DIVISION, DNR & C 1976

TABLE 3-1

EXISTING TRANSMISSION LINES DATA

	Line	Wire Size or Code No.	Length (Miles)	Year Constructed	Voltage in kV	Present Load-MW (1975 Load Flow)	Maximum Load Carrying Capacity[1] in MW
1.	Bozeman to Meadow Village	3/0 ACSR	43.6	1972	69	8.0	9.0
2.	Madison to Trident	C6H11	34.00	1909	50	0.9 M to T.F. 2.0 Tr to T.F.	2.1
3.	McAllister to Ennis	A336	6.30	1969	50	1.6	16.0
4.	Ennis to Madison Valley	A3/0	23.90	1969	50	0.8	7.2
5.	Madison to Ruby	C6	25.70	1906	50	1.6	2.7
6.	Ruby to Sheridan	C3S9	10.50	1911	50	0.2	0.9
7.	Twin Bridges to Sheridan	C359	9.00	1911	50	0.7	1.0
8.	Renova to Twin Bridges	C3S8 C2Y	23.60	1937-38	50	1.8	5.0
9.	Clyde Park-Livingston (1)	A336	12.50	1954	50	8.3	17.0
	(2)	A336	12.70	1966	50	8.4	17.0
10.	Bozeman South Side-Madison	C1/0	36.50	1909	50	6.4	5.0
11.	Bozeman So.-Livingston	C7S8 C1/0	24.60	1939-41	50	4.2	7.0
12.	Bozeman-Belgrade-Trident	C3S8	29.70	1908-10	50	0.2 Boz-Bel 5.4 Tri-Bel	5.0
13.	Renova to Madison	C1/OH	33.70	1915	100	5.9	19.0

SOURCE: Montana Power Company, System Data Book.

[1] Without compensating equipment, at receiving end .9 PF lag, up to 8% voltage drop; sending end voltage is 100%.

Within the study area, the general trend in load growth is partially associated with the change in demographic character. Table 3-2 shows that population growth has been largely confined to Gallatin County, and the City of Bozeman in particular. The table presents population figures by census division, and Figure 3-1 shows outlines of these divisions within each county. Rural census divisions have tended to lose people while urban divisions have grown. Two conspicuous exceptions to this rule are the City of Livingston, with a declining population, and the Gallatin Canyon (i.e., Gallatin Gateway and West Yellowstone divisions), which is experiencing population growth.

The demographic pattern of the 1960's appears to be extending itself into the current decade (see Table 3-3). Gallatin County remains the major growth center, although population change appears to have leveled off in the past two years. In recent years, the major impetus to population change in Gallatin County has been Montana State University. There, enrollments climbed from 3,889 students in 1960 to 8,187 in 1970, and to 8,971 in the fall of 1975. A steady enrollment of approximately 8,200 has been the norm in the 1970's.[1] Park and Beaverhead Counties have retained static population levels; Madison County is experiencing some growth. The Montana Department of Community Affairs has developed four population projections for each of the counties in the study area (see Table 3-4).

Population growth is only one variable affecting electrical load growth. Loads can increase independent of demography through more intensive and extensive use of electrical equipment, heating, illumination, recreation, and so forth. For example, utilities have frequently cited increased load from irrigation as a causal variable in load growth. The study area (see Figure 2-2 delineating the study area in Chapter 2) contains some of the most productive agricultural land in the state. Irrigated land makes up approximately 73% of all cropland, and accounts for about 80% of the crop value in the four-county area.[2] All indications are that irrigation will continue to expand in the region. The distribution of new applications for water use is shown on Figure 3-2; most of them are for irrigation purposes. The numbers on Figure 3-2 refer to a listing of details in Technical Appendix E concerning the location, source, amount, description, and number of acres to be irrigated. The applications were filed during 1973 and 1974 with the Water Resources Division of the Department of Natural Resources.

3.2.1. Big Sky Load

3.2.1.1. General Information

The Big Sky ski area is located on U.S. 191, 43 miles south of Bozeman and 46 miles north of West Yellowstone. It is a joint venture of the Chrysler Corporation, Continental Oil Company, the applicant Montana Power Company, Northwest Airlines, and the Chet Huntley Estate.

At present, the Big Sky resort consists of two sections known as Mountain Village and Meadow Village. A date of 1980-81 was originally set for terminating Big Sky's construction, but general recessionary pressures in the economy appear to have slowed its growth, and the resort is currently

TABLE 3-2

CLYDE PARK-DILLON STUDY AREA POPULATION
County, Census Division, and Year

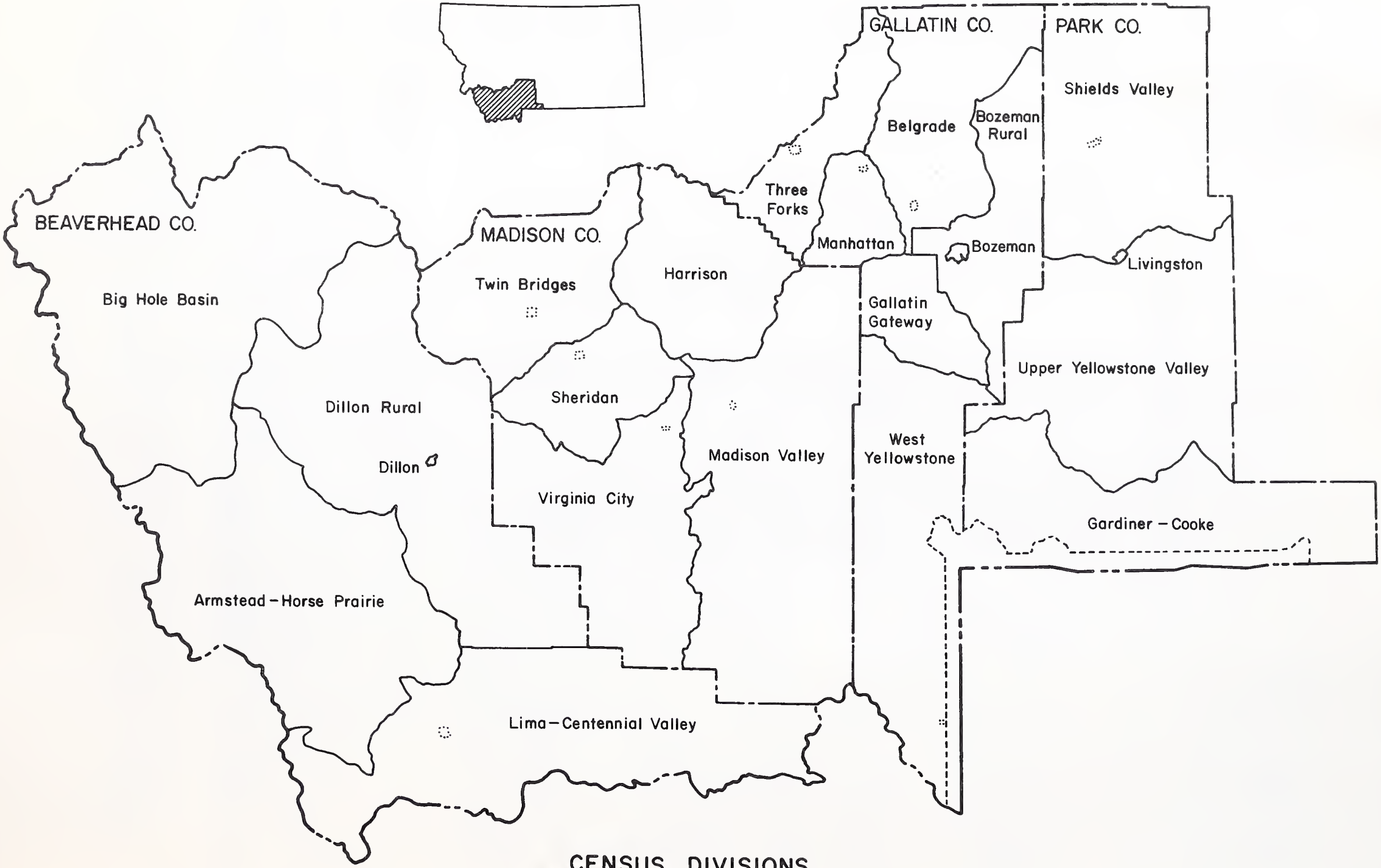
	1960 Population	1970 Population	1960-1970 Numerical Change	1960-1970 Percent Change
Beaverhead County	7,194	8,187	+ 993	+ 13.8%
Armstead-Horse Prairie division	564	374	- 190	- 33.7%
Big Hole Basin division	766	720	- 46	- 6.0%
Dillon division[1]	3,690	4,548	+ 858	+ 23.3%
Dillon Rural division	1,473	1,906	+ 433	+ 29.4%
Lima-Centennial Valley division	701	639	- 62	- 8.8%
Gallatin County	26,045	32,505	+6,460	+ 24.8%
Belgrade division	2,446	2,951	+ 505	+ 20.6%
Bozeman division[1]	13,361	18,670	+5,309	+ 39.7%
Bozeman Rural division	4,087	4,029	- 58	- 1.4%
Gallatin Gateway division	1,019	1,469	+ 450	+ 44.2%
Manhattan division	2,575	2,448	- 127	- 4.9%
Three Forks division	1,958	1,839	- 119	- 6.1%
West Yellowstone division	599	1,099	+ 500	+ 83.5%
Madison County	5,211	5,014	- 197	- 3.8%
Harrison division	921	800	- 121	- 13.1%
Madison Valley division	1,078	1,179	+ 101	+ 9.4%
Sheridan division	1,330	1,337	+ 7	+ 0.5%
Twin Bridges division	1,549	1,437	- 112	- 7.2%
Virginia City division[2]	333	261	- 72	- 21.6%
Park County	13,168	11,197	-1,971	- 15.0%
Gardiner-Cooke division	929	845	- 84	- 9.0%
Livingston division[1]	8,229	6,883	-1,346	- 16.4%
Shields Valley division	1,699	1,808	+ 109	+ 6.4%
Upper Yellowstone Valley division	2,311	1,661	- 650	- 28.1%
Yellowstone National Park division	47	64	+ 17	+ 36.2%

SOURCE: U.S., Bureau of the Census, U.S. Census of Population: 1970 Number of Inhabitants, Final Report PC (1) - A28, Montana. Government Printing Office, Washington, D.C.; 1970.

NOTE: Each county is divided into a number of geographical areas for purposes of census enumeration. These geographical areas are the census divisions.

1. Refers to the population of the incorporated city. Also the county seat.

2. Virginia City, the county seat of Madison County, had a 1970 population of 149. Its population is contained within figures for the Virginia City division.



CENSUS DIVISIONS

SOURCE: U.S. BUREAU OF THE CENSUS 1970

Figure 3-1

TABLE 3-3

CLYDE PARK-DILLON STUDY AREA POPULATION
by County and Year

	1970	1971	1972	1973	1974[1]	Percentage Change 1970-1974
Beaverhead County	8,187	8,300	8,200	8,200	8,300	+ 1.4%
Gallatin County	32,505	33,800	35,000	36,000	36,000	+ 10.8%
Madison County	5,014	5,200	5,600	5,500	5,900	+ 17.7%
Park County[2]	11,261	11,800	11,800	11,900	11,900	+ 5.7%
Montana	694,409	710,000	716,000	730,000	735,000	+ 5.8%

SOURCE: U.S., Bureau of the Census, Current Population Reports, Series P-26 Montana. Government Printing Office, Washington, D.C.; 1972-1975.

1. The 1974 estimates are preliminary and subject to revision.

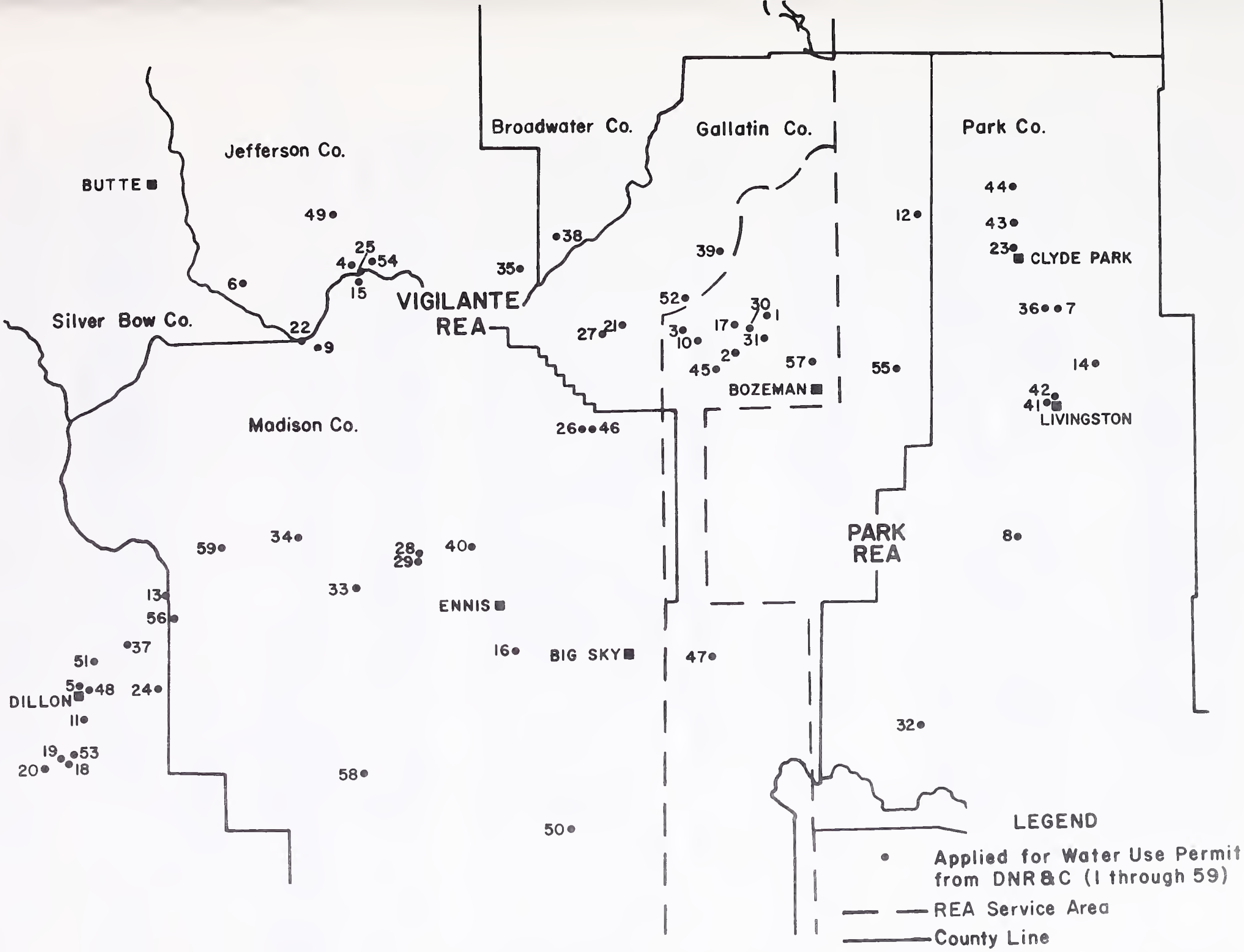
2. The population of Yellowstone National Park is included with Park County.

TABLE 3-4

CLYDE PARK-DILLON STUDY AREA
FOUR SCENARIO POPULATION PROJECTIONS

	Scenario I Continued 1960-1970 Migration Trends To 1980		Scenario II No Net Migration From 1970 To 1980		Scenario III 50% Decrease in 1960-70 Migration Trends From 1970-80		Scenario IV 50% Increase in 1960-70 Migration Trends From 1970-80	
	1975	1980	1975	1980	1975	1980	1975	1980
Beaverhead County	8,882	9,606	8,678	9,068	9,154	10,335	8,610	8,886
Gallatin County	36,034	39,661	34,537	35,677	38,133	45,271	33,924	34,042
Madison County	4,911	4,699	5,115	5,245	5,116	5,250	4,709	4,154
Park County	10,242	9,201	11,141	11,598	10,719	10,470	9,767	7,937

SOURCE: Montana Department of Community Affairs, County Profiles (for each county indicated). Helena, Montana; April 1974.



NEW APPLICATIONS FOR WATER USE – PRIMARILY FOR IRRIGATION

1973 – 1974

Figure 3-2

one year behind on its anticipated sales of condominiums and residential sites. Mr. Vernon Blakely, President of Big Sky, stated: "At the moment we have 200 condominiums in stock. That's 100 more than we wanted. Now it looks like we won't build any more condominiums for two years."[3] Technical Appendix B contains a listing of facilities which have already been constructed at Big Sky.

The total investment for the development of Big Sky over the next seven or eight years is estimated to be in excess of $60 million. The master plan calls for construction of about 1200 home sites and 2700 condominiums, as well as other facilities, including ski runs, a 125-car gondola, village mall houses, various shops, restaurants, a cafeteria, a sports center, and others (see Technical Appendix A). Table 3-5 indicates contemplated additions of facilities by Big Sky to meet its master plan of full development.

According to Mr. Gustav Raaum, Chairman of Big Sky's Board of Directors, only about 30% of the resort's 10,600 acres (about 16 square miles) will be developed. When fully completed, the resort will accommodate 16,400 persons a day during ski season.

3.2.1.2. History of Existing 69-kV Line at Big Sky and Historical Load

Application was made by Montana Power Company on March 26, 1971, for a 50-kV transmission line and a 12-kV distribution underbuild. A permit for this application was issued by the Forest Service on January 1, 1973. Later, at a meeting between the Forest Service and Montana Power Company, the applicant requested to upgrade the 50-kV line to a 69-kV line. On March 5, 1974, the Forest Service gave approval to upgrade the line. Three months later on June 6, 1974, Montana Power Company filed the application with the Department for which this study is being done--to construct a 161-kV line.

Technical Appendix B-2 contains information about Special Use Permits granted to Montana Power Company by the U.S. Forest Service affecting the length and capacity of existing 50/69-kV lines from Bozeman to Big Sky.

Before 1973, Big Sky's electric load was recorded as part of the Gallatin Gateway district. The historical load and number of customers for the Gallatin Gateway are listed in Table 3-6.

3.2.1.3. Projection

Big Sky, Inc., is developing and expanding its recreational area according to its master plan (see Technical Appendix A). If Big Sky's long-range plans are completed, additional electricity will be required.[4] The existing electrical delivery system will not accommodate projected loads.

The electrical load projections from both Big Sky and the applicant indicate a need for over 30 MW of power. Table 3-7 gives electrical demand figures in kilowatts (KW) prepared by the applicant for the Big Sky area through 1981. The last column, entitled "notes," refers to an explanation

TABLE 3-5

BIG SKY OF MONTANA, INC.
ADDITIONAL FACILITIES ANTICIPATED TO MEET MASTER PLAN

Additional Facilities	Quantity
Total Single Family Lots in the Master Plan	1,263
Homes Built to Date	37
Additional Homes to be Build	1,226
Total Condominiums in the Master Plan	2,700
Total Condominiums Built to Date	564
Additional Condominiums to be Built (with supporting facilities, i.e., pools)	2,136
Additional Commercial Space	89,000 Square Feet
Additional Hotels - 4 @ 100 Rooms	400 Rooms
Gas Station	
Warehouse	
Property Management Offices	
Security and Fire Department Building	
Alpine Restaurants Top of Andesite Top of Upper Gondola Station	2
Additional Recreation Facilities	9 Holes Golf 16 Tennis Courts w/Recreation & Pool (cover at least two courts) 6 Ski Lifts - (5 @ 250 HP and 1 @ 150 HP) Boat House & Marina Trap Shoot Equestrian Center
Additional Roads, Sewer, Water, Telephone, etc. to Service above Expansion	

SOURCE: Written Communication, Big Sky Inc., (Mr. Gustav Raaum) to Mr. Charles Greene, Energy Planning Division, October 29, 1975.

TABLE 3-6

Historical Load and Number of Customers for Gallatin Gateway

YEAR	PEAK DEMAND IN KW	NUMBER OF CUSTOMERS
1964	1480	690
1965	1575	740
1966	1570	760
1967	1710	760
1968	1730	760
1969	1800	870
1970	2300	910
1971	3650	1050
1972	3650	1180
1973	3020	1370
1974	2350	1090

SOURCE: Montana Power Company

TABLE 3-7

BIG SKY'S ANTICIPATED KW DEMAND

SEASON 1973-1974

HIGHWAY 191 LOCATION

	KW	Notes[1]
Big Sky Sales Office	25	(1)
Big Sky Visitors Center	15	(2)
Big Sky Mobile Offices	10	(3)
Lone Mountain Offices	25	(4)
Continental Oil Co. Station	100	(5)
TOTAL	175	

MEADOW VILLAGE

	KW	Notes
Big Sky B-K Guest Ranch	150	(6)
Big Sky Convention Center	50	(7)
Big Sky Country Store	75	(8)
Big Sky Employee Housing	100	(9)
Big Sky Black Otter Lodge	25	(10)
Big Sky Pumps	25	(11)
Big Sky Sewage Plant	100	(12)
Big Sky Golf Cart Garage	25	(13)
Big Sky Silver Bow Bath House	75	(14)
Big Sky Yellowstone Bath House & Headbolt Heaters	100	(15)
Madison Valley Telephone	50	(16)
Yellow Mule Restaurant	175	(17)
Big Sky Hotel - LeFevre	100	(18)
Condominiums:		
Silverbow I 50 units	500	(19)
Silverbow II 20 units	200	(20)
Yellowstone 42 units	400	(21)
Broadwater 72 units	100	(22)
Residences:		
22 units	300	(23)
TOTAL	2,550	

MOUNTAIN VILLAGE

	KW	Notes
Big Sky Water System	100	(24)
Big Sky Construction Office	50	(25)
Big Sky Employee Housing	75	(26)
Big Sky Mall Operations and 3 Lifts	800	(27)
Mall Commercials	500	(28)
Big Sky Clinic	75	(29)

TABLE 3-7 (continued)

	KW	Notes
SEASON 1973-1974 - (Continued)		
MOUNTAIN VILLAGE - (Continued)		
Condominiums:		
Stillwater	600	(30)
Deer Lodge (Construction)	200	(31)
Chrysler Camper Village	250	(32)
Mobile Home Court	200	(33)
Big Sky Hotel Construction	200	(34)
Miscellaneous Construction	150	(35)
TOTAL	3,200	
SEASON 1974-1975		
HIGHWAY 191 LOCATION		
No change	175	
MEADOW VILLAGE		
Additional:		
Warehouse	25	(36)
Condominiums:		
Broadwater	300	(37)
Glacier	600	(38)
New Residences	100	(39)
TOTAL	1,025	
MOUNTAIN VILLAGE		
Big Sky Hotel	1,800	(40)
300 hp Gandola lift (On diesel 1973-74)	200	(41)
Condominiums:		
Deer Lodge 126 units	800	(42)
2 pools, 2 garages	200	(43)
Hill 180 units partial construction	750	(44)
2 pools?	150	(45)
Lake 4 units	50	(46
Beaverhead 4 units - 1974	50	(47)
TOTAL	4,000	

TABLE 3-7 (continued)

SEASON 1975-1976

	KW	Notes
HIGHWAY 191 LOCATION		
No change	175	
MEADOW VILLAGE		
Equestrian Center	25	(48)
Condominiums:		
Broadwater Pool	75	(49)
Glacier Pool		
Construction 10 units	95	(50)
Residences:		
12 completed (additional load)	75	(51)
12 new	75	(52)
TOTAL	345	
MOUNTAIN VILLAGE		
Additional water pumping	50	(53)
1st Alpine restaurant	200	(54)
Marina	100	(55)
Gas station	100	(56)
50 room lodge	150	(57)
Condominiums:		
30 Beaverhead additions	250	(58)
New units 20	200	(59)
Residences	100	(60)
TOTAL	1,150	

SEASON 1976-1977

	KW	Notes
HIGHWAY 191 LOCATION		
No change	175	
MEADOW VILLAGE		
Condominiums:		
1 Pool	75	(61)
75 new units	150	(62)
Residences:		
Completions	100	(63)
12 additional	100	(64)
TOTAL	425	

TABLE 3-7 (continued)

SEASON 1976-1977 - (Continued)

MOUNTAIN VILLAGE

	KW	Notes
Additional 300 hp lift	250	(65)
Additional 50 room lodge	200	(66)
Condominiums:		
Beaverhead 50 additional units	500	(67)
New units 175	1,000	(68)
3 pools	200	(69)
Residences:		
15 new units	200	(70)
TOTAL	2,350	

SEASON 1977-1978

HIGHWAY 191 LOCATION

	KW	Notes
No change	175	

MEADOW VILLAGE

	KW	Notes
Increased pump and sewage	75	(71)
Condominiums:		
Completion	700	(72)
150 new units	300	(73)
2 new pools	150	(74)
Residences:		
35 new units	400	(75)
TOTAL	1,625	

MOUNTAIN VILLAGE

	KW	Notes
Additional 30,000 sq. ft. commercial space	400	(76)
Additional 150 hp. lift	150	(77)
Additional 50 room lodge	200	(78)
Condominiums:		
Additional 350 units	3,000	(79)
Additional 6 pools	400	(80)
Residences:		
35 additional	500	(81)
TOTAL	4,650	

TABLE 3-7 (continued)

	KW	Notes
SEASON 1978-1979		
HIGHWAY 191 LOCATION		
No change	175	
MEADOW VILLAGE		
Condominiums:		
Completions	700	(82)
92 new units	100	(83)
2 additional pools	150	(84)
Residences:		
Completions	200	(85)
40 new units	200	(86)
TOTAL	1,350	
MOUNTAIN VILLAGE		
Additional 250 hp lift	250	(87)
Additional 50 room lodge	200	(88)
Condominiums:		
Completions	1,000	(89)
436 new units	2,500	(90)
7 additional pools	450	(91)
Residences:		
40 additional	400	(92)
completions	175	(93)
TOTAL	4,975	
SEASON 1979-1980		
HIGHWAY 191 LOCATION		
No change	175	
MEADOW VILLAGE		
Condominiums:		
Completions	700	(94)
1 new pool	75	(95)
Residences:		
40 additional	500	(96)
TOTAL	1,275	

TABLE 3-7 (continued)

SEASON 1979-1980 - (Continued)

	KW	Notes
MOUNTAIN VILLAGE		
Completed	50	(97)
Condominium completion	1,500	(98)
Residences:		
45 new units	600	(99)
TOTAL	2,150	
SEASON 1980-1981		
HIGHWAY 191 LOCATION		
No change	175	
MEADOW VILLAGE		
Residential completion	300	(100)
TOTAL	300	
MOUNTAIN VILLAGE		
Construction power decrease	(150)	(101)
Residences:		
Completion	200	(102)
50 new units	750	(103)
TOTAL	800	
GRAND TOTALS 1973-1981		
Highway	175	
Meadow Village	8,895	
Mountain Village	23,275	
	32,345	

SOURCE: Written Communication, Montana Power Company to Department, October 20, 1975.

[1] Refer to Technical Appendix B according to numbers listed for an explanation of how demand figures were calculated.

of the procedures used to calculate the demand figures; they are explained in Technical Appendix B. Table 3-8 shows a recapitulation of total electrical demand figures according to season. The design details necessary for calculating the electrical requirements for condominiums, residences, sewage facilities, swimming pools, hotels and lodges, and ski lifts are given in the published Appendix at the end of this publication. According to Big Sky calculations, the total installed capacity of its facilities will be 56,650 KW (see Technical Appendix A). However, it is unlikely that operation of the resort will ever be at 56,650 KW level (i.e., not all electrical facilities will be running at the same time). The applicant has figured peak demand at any one time to be 32,170 KW.

TABLE 3-8

RECAPITULATION OF DEMAND
BIG SKY COMPLEX

Season	Highway	Meadow Village KW	Mountain Village KW	Total Demand Winter Peak KW	Total Demand Summer Peak KW
1973-1974	175	2,550	3,200	5,925	4,750
1974-1975	175	3,575	7,200	10,950	6,660
1975-1976	175	3,920	8,350	12,445	8,250
1976-1977	175	4,345	10,700	15,220	10,560
1977-1978	175	5,970	15,350	21,495	12,672
1978-1979	175	7,320	20,325	27,820	15,713
1979-1980	175	8,595	22,475	31,245	19,484
1980-1981	175	8,895	23,275	32,345	24,160

SOURCE: Written Communication, Montana Power Company to Department, October 20, 1975.

3.2.1.4. Summary

According to Table 3-1, the capacity of the existing 69-kV line from Bozeman to Big Sky is 9 MW. This capacity can be increased by 12 to 15 MW through the installation of voltage compensation equipment at Big Sky, depending on the installed equipment design and load conditions. As has been discussed, load projections made by the applicant based upon Big Sky long-range development plans exceed 30 MW. Because the growth rate at Big Sky is dependent upon Montana and nationwide economic conditions, the accuracy of these load projections is difficult to judge. However, if Big Sky is to continue to expand, additional transmission capacity will be necessary. A change in the developmental philosophy of Big Sky management away from the "all electric" resort concept, or to increase the efficiency of electrical consumption, could result in a reduction in the projected energy loads, but no change appears imminent. The Department may not have the authority to force such a change, but would like to express deep concern for energy conservation and to encourage the Big Sky developer to employ all possible means to decrease energy consumption.

3.2.2. Bozeman Load

The Bozeman area is served by four transmission lines; three are 50-kV lines, and one is a 161-kV line. Ninety percent of the total load is served by the 161-kV line, which has its source at the Clyde Park substation. Table 3-9 shows the Bozeman area's historical load and number of customers from 1962 to 1974. Load projections made on a linear, historical basis are also given in Table 3-9.

3.2.3. Yellowstone National Park and Upper Yellowstone Valley Loads

Yellowstone National Park receives its power from the Montana Power Company, and the Upper Yellowstone Valley is served by the Park Electric Cooperative and the Montana Power Company. Other small towns in the study area, including Ennis, Virginia City, Twin Bridges, and Sheridan are served by the Montana Power Company. Figure 3-3 gives historical load data at different substations in Yellowstone Park.

The Upper Yellowstone Valley, including the portion containing Yellowstone Park, is an area of peak summer demand, the peak demand usually occurring in the summer months. Table 3-10 gives the number of customers during the last five years in the Upper Yellowstone Valley. Table 3-11 lists projected electrical peak loads which will be served by the Montana Power Company in the study area.

3.2.4. Rural Electric Cooperatives' Load

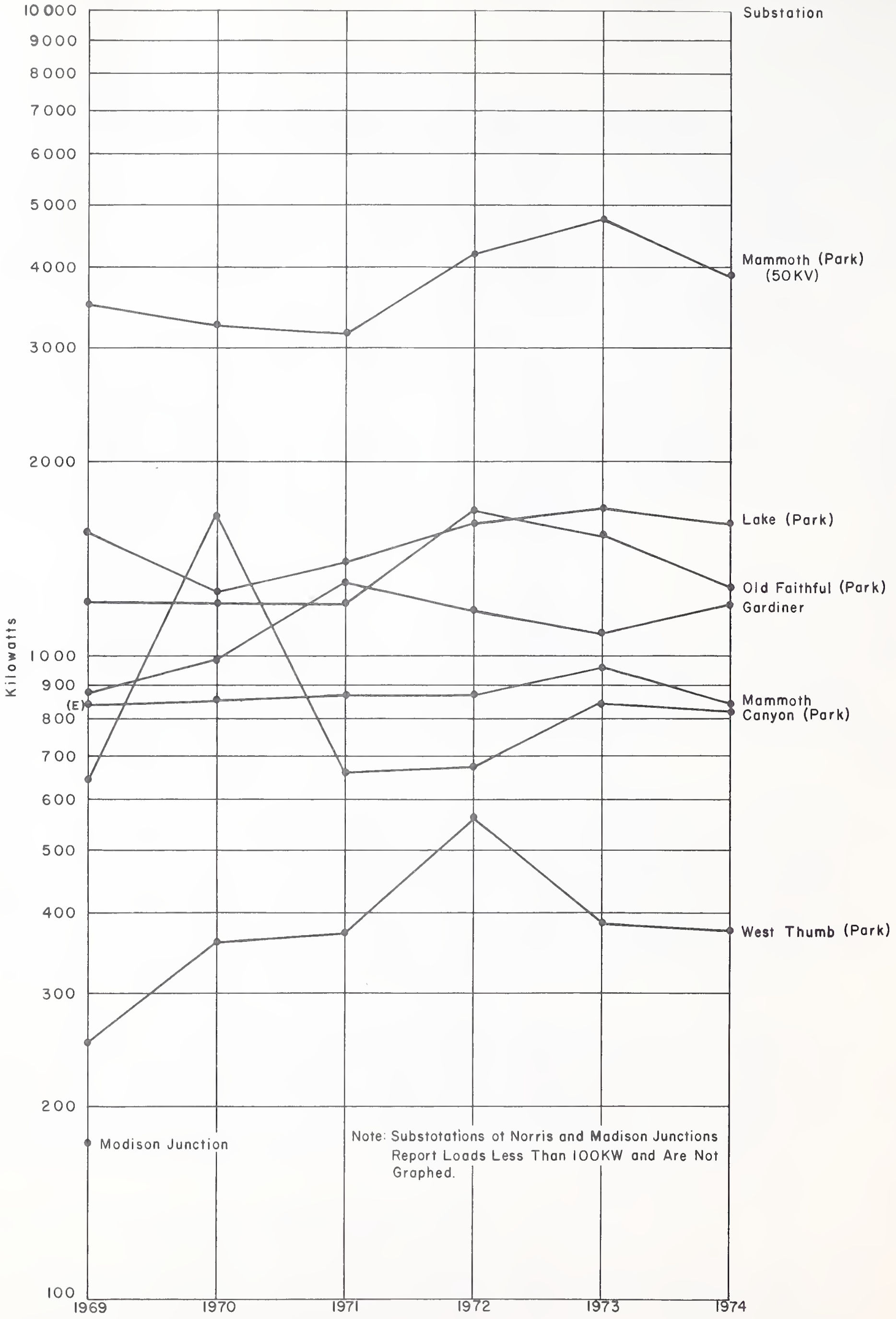
In addition to Montana Power Company, electrical services in the study area are also provided by the Park Electric Cooperative (PEC) and the Vigilante Electric Cooperative (VEC). PEC buys power from MPC and the Central Montana Generation and Transmission Cooperative (which buys power

TABLE 3-9

HISTORICAL LOAD AND NUMBER OF CUSTOMERS FOR THE BOZEMAN AREA

YEAR	PEAK DEMAND IN KW	NUMBER OF CUSTOMERS
1962	12,900	5,600
1963	13,000	5,700
1964	13,800	5,900
1965	13,900	6,050
1966	15,100	6,500
1967	17,800	6,600
1968	19,600	6,750
1969	21,500	6,800
1970	23,500	6,900
1971	24,000	7,000
1972	26,000	7,300
1973	25,000	7,350
1974	28,000	8,000
1979	33,400	9,520
1984	39,700	11,330

SOURCE: Montana Power Company, 1975.



Note: Substatations of Norris and Madison Junctions Report Loads Less Than 100KW and Are Not Graphed.

PEAK ELECTRIC LOAD GARDINER, MAMMOTH AND YELLOWSTONE PARK

SOURCE: MONTANA POWER CO., 7-10-1975

Figure 3-3

TABLE 3-10

UPPER YELLOWSTONE VALLEY
Customers Served

	1969	1970	1971	1972	1973	1974
Park Electric Coop.[1]	1,412	1,441	1,489	1,565	1,651	NA
Gardiner[2]	381	396	417	431	431	465
Mammoth, Wyoming	137	140	142	145	144	192
Yellowstone Nat'l Park	13	11	12	11	11	11

SOURCES: Park Electric Cooperative, Inc., Power Requirement Study For 1978-1983. Livingston, Montana, July 1974; and Annual Report of Montana Power Company Consolidated, Electric Utility, to Public Service Commission of Montana (for each year indicated).

[1] Includes all system customers irrespective of geographical location.

[2] Gardiner, Mammoth, Wyoming, and Yellowstone National Park are served by the Montana Power Company.

TABLE 3-11

PROJECTED ELECTRICAL PEAK LOAD AT DIFFERENT SUBSTATIONS IN THE STUDY AREA IN KILOWATTS (kW)

Year	Gardiner	Yellowstone Park	Ennis Area	Virginia City	Twin Bridges & Sheridan	Point of Rock With Co-op Load
1973	1250	5300	1968	520	2600	1120
1974	1300	5700				
1975	1370	6150				
1976	1440	6600	2950	562	3150	1200
1977	1510	7100				
1978	1600	7780	3700	587	3400	1350
1979	1690	8280				
1980	1780	8760	4400	620	3800	1750

SOURCE: Montana Power Company, Application for Certificate of Environmental Compatibility and Public Need, Clyde Park-Dillon Transmission Facility; June 6, 1974.

from MPC, federal agencies, and utilities in North Dakota). VEC buys power from federal agencies and MPC.

Energy sales and projected load for Vigilante Electric Cooperative are given in Table 3-12. For more detail, see Technical Appendix C.

TABLE 3-12

VIGILANTE ELECTRIC COOPERATIVE ENERGY SALES AND PROJECTED LOAD

kWH Sold	Peak KW	Projected Load in kWH
1969 - 30,186,604	6,992	1974 - 51,792,420
1970 - 30,640,629	7,200	1975 - 58,363,260
1971 - 36,671,854	8,318	1976 - 65,202,120
1972 - 39,560,845	9,615	1977 - 72,365,340
1973 - 45,511,174	11,985	1978 - 79,861,920

SOURCE: Vigilante Electric Cooperative, written communication to Department, August 7, 1974.

The following table (Table 3-13) shows the energy sales and projected load of Park Electric Cooperative (for more detail, see Technical Appendix D). The projections for Park Electric Cooperative are prepared by its engineering consultant.

TABLE 3-13

PARK ELECTRIC COOPERATIVE ELECTRICAL ENERGY
SALES AND PROJECTION

Year	kW	kWH
1963	2568	10,599,778
1964	3078	11,575,392
1965	2664	11,776,266
1966	2874	12,326,940
1967	2967	12,948,696
1968	3338	13,699,680
1969	3452	14,332,241
1970	3427	15,327,110
1971	4199	17,815,932
1972	5002	18,633,718
1973	4894	20,176,119
1978	6467	26,588,321
1983	8904	36,420,844

3.3. System Reliability and Problem Service Areas

Montana law provides that the Public Service Commission is empowered to establish rules and standards for service as follows:

> The Commission shall ascertain and fix adequate and serviceable standards for the measurement of quality, pressure, initial voltage, or other conditions pertaining to the supply of the product or service rendered by any public utility, and prescribe reasonable regulations for examination and testing of such product or service and for the measurement thereof. (Section 70-112, R.C.M. 1947)

In accordance with the above statute, the Public Service Commission adopted the following rule concerning voltage levels (Electric Service Regulations and Schedules prescribed by the Public Service Commission for MPC, effective January 1, 1961, revised December 8, 1967; adopted into the Montana Administrative Code in Section 38-2.14 (1) - S1400):

Rule 805 Voltages - Utility shall adopt nominal standard, alternating current voltages for its entire distribution system, or for each of the several areas into which the system may be divided. Utility shall, upon request from Commission, customer, or prospective customer, furnish statement of the nominal standard voltages for any specific area. The voltages shall be maintained at a reasonably constant value at any customer's point of delivery, as follows:

a) For service to residential and commercial customers, the voltage variation shall not exceed six percent plus or minus from the nominal standards within the corporate boundaries of cities and towns having a population of 2500 or more, nor eight percent plus or minus in all other places.

b) For service rendered primarily for power purposes and for other service rendered under power rate schedules, the voltage shall not exceed ten percent plus or minus from the nominal standard voltages.

c) A greater variation of voltage than specified above may be allowed when contracts of rate schedules so provide, when service is supplied directly from a transmission line, or in areas where customers are widely scattered, or the revenue does not justify close voltage regulations.

In order to maintain customer service voltage within a ±6% or ±8% variation, each utility company adopts its own operating rules. Usually, the utility company allows up to 8% voltage drop (up to 15% in some cases) in the transmission system under normal conditions. Voltage regulators are used to control voltage drop and boost the voltage to normal levels, but these devices have operating limits.

When electrical loads increase, the voltage drop on the transmission line also increases. Additional lines may be required to provide adequate service or the entire existing system may need upgrading. When a fault occurs on one line or an interconnected system of lines, the remaining lines have to carry extra load, and in that situation, some lines may exceed the voltage drop limitation. This creates a condition of poor service reliability which the utility companies may be required to correct or prevent.

The Wilsall-Clyde Park 161-kV line, which was approved by the Board of Natural Resources on June 26, 1975, will help to offset the voltage drop in the Yellowstone Park area to some degree, but will not completely solve the problem. Table 3-14 provides information about the Wilsall-Clyde Park line.

A load flow analysis creates a "steady-state" solution for an electric network. This is a "snapshot" view of a dynamic system. The load flow analysis determines the voltage, current, power flow, power factor, reactive power, phase angle, any mismatches or overloading of transmission lines, transformers, and generators at various points under existing or contemplated

TABLE 3-14

VOLTAGE LEVELS WITH AND WITHOUT ADDITION OF WILSALL-CLYDE PARK 161-kV LINE

	Transmission Line Voltage Levels Without Wilsall-Clyde Park 161-kV Line				
Load Condition	at Clyde Park	at Bozeman	at Livingston	at Gardiner	at Yellowstone
Normal operation of existing system using 1976 heavy electrical demand figures	2.7% drop (.973)	1.2% drop (.988)	5% drop (.95)	12% drop (.877)	19% drop (.807)
Clyde Park-Big Timber 161-kV line out of service, and using 1976 heavy electrical demand figures	12.1% drop (.879)	12.3% drop (.877)	16.5% drop (.835)	40% drop (.596)	49.1% drop (.459)
	Transmission Line Voltage Levels With Wilsall-Clyde Park 161-kV Line				
Normal operation of existing system using 1976 heavy electrical demand figures	rise 2.2% (1.022)	rise 3.2% (1.032)	rise 1% (1.01)	drop 3.1% (.969)	drop 9.1% (.909)
Clyde Park-Big Timber 161-kV line out of service, and using 1976 heavy electrical demand figures	rise 0.8% (1.008)	rise 1.8% (1.018)	drop .04% (.996)	drop 5.2% (.948)	drop 11.3% (.887)

SOURCE: Montana Power Company, 1975.

conditions in an electric network. This information is essential to evaluate the reliability and performance of a power system, and to analyze the effectiveness of potential plans for system expansion to meet increased load demand. These analyses require load flow calculations for normal as well as emergency operating conditions, and they reveal normal and emergency situations in specific locations.

Table 3-15 tabulates the 11 studies of load flow provided by the applicant and prepared by the Department. These cases have been prepared by making the appropriate changes in the existing system. The changes can be used to check the validity of different alternatives to satisfy the electricity requirements, and to check and solve existing problems. The projected loads are used at different load centers solving load flow cases for 1979. The voltages at each load center should not be lower than 92% (or .92 Per Unit), meaning that the drop should not be more than 8% (or 0.08 Per Unit). Voltage below .92 P.U. is below the Public Service Commission's standards of customer service. The different purposes of all 11 load flow cases are summarized in Table 3-15, although some of them are discussed here. Case one, relating to the existing system, indicates that voltages at Big Sky and in Yellowstone Park at Thumb and Old Faithful are below 92% (.92 P.U.). Adding the Clyde Park to Wilsall 161-kV line (Case 2) has improved the voltage drop condition in Yellowstone Park to some degree, but not at Big Sky. Case three analyzes the effects of upgrading the existing Renova to Ennis 50-kV line to a 100-kV line, and connecting the 100-kV line to the Madison hydro plant, and extending it to Big Sky. The result of case three indicates that load of 15 MW at Big Sky will have a voltage level of 89.7% (or .897 P.U.), which is lower than the required 92%. Thus, all the different cases have been run for different purposes, which can be seen in one column of the table showing line additions or removals.

Service reliability is also a major concern with respect to electrical delivery at Bozeman, Big Sky, the Upper Yellowstone Valley, and in Yellowstone Park. In the latter two areas, the applicant claims that voltage levels are (or soon will be) below the requirements set by the Public Service Commission.

System reliability is partially evaluated by existing line outages. Table 3-16 provides outage data. Based upon these data and the preceding discussions, the following areas are considered either problem or critical areas.

1. Yellowstone Park Service Area. The voltage drop is more than 8% in summer. (Case 8 in Table 3-15 gives actual figures showing an 11.6% drop.)

2. Park Electric Cooperative Services. Park Electric Cooperative Services in the Livingston and Chico areas are shown in Figure 3-4. The voltage drop exceeds 8%, and in some places, it is 11%.

3. Big Sky Area. A voltage drop of greater than 8% occurs when the load is 9 MW or more (at 9 MW, the voltage drop is 1-.895 P.U. = 0.105 P.U. or 10.5%). In addition, Big

TABLE 3-15

SUMMARY OF TRANSMISSION SYSTEM STUDY
LOAD FLOW - WITH EXISTING SYSTEM AND WITH CHANGES

			Big Sky		Substation At Thumb		Substation At Old Faithful		
No.	Transmission Lines Added In Existing System	Transmission Lines Removed (or Open) From Existing System	Load In MW	Voltage In Per Unit (P.U.)	Load In MW	Voltage In Per Unit (P.U.)	Load In MW	Voltage In Per Unit (P.U.)	Remarks
1.	None	None	6.9	.31	.5	.78	1.3	.804	Bozeman-Big Sky 50-kV line
2.	Clyde Park-Wilsall 161-kV	None	15	.553	0.0	.989	.2	.987	Bozeman-Big Sky 50-kV line
3.	1) Clyde Park-Wilsall 161-kV 2) Renova-Ennis-Big sky 100-kV 3) Madison-Ennis 100-kV	1) Renova to Twin Bridges 50-kV 2) Twin Bridges-Sheridan 50-kV 3) Sheridan-Granite Creek 50-kV 4) Bozeman-Big Sky 69-kV	15	.897	.5	.938	1.3	.952	Yellostone heavy load large wires voltage at Renova .969 P.U.
4.	1) Madison-Big Sky 100-kV 2) Clyde Park-Wilsall 161-kV 3) Clyde Park-Bozeman "B" 161-kV	1) Bozeman-Big Sky 69-kV	15.0	.845	0.0	1.048	.3	1.047	Voltage at Madison .887 P.U. and at Renova .921 P.U.
5.	1) Madison-Big Sky 100-kV 2) Clyde Park-Wilsall 161-kV 3) Clyde Park-Bozeman "B" 161-kV 4) Tie line 161-kV Three Rivers to Renova	1) Bozeman-Big Sky 69-kV	15.0	.882	0.0	1.050	.3	1.049	Voltage at Madison .992 P.U. and at Renova .956 P.U.

Table 3-15 (continued)

No.	Transmission Lines Added In Existing System	Transmission Lines Removed (or Open) From Existing System	Big Sky		Substation At Thumb		Substation At Old Faithful		Remarks
			Load In MW	Voltage In Per Unit (P.U.)	Load In MW	Voltage In Per Unit (P.U.)	Load In MW	Voltage In Per Unit (P.U.)	
6.	1) Madison-Big Sky 161-kV 2) Clyde Park-Wilsall 161-kV 3) Clyde Park-Bozeman "B" 161-kV	None	9.0	.953	0.0	1.072	.2	1.071	Voltage at Madison .956 P.U.; Renova .950 P.U.
7.	1) Madison-Big Sky 161-kV 2) Clyde Park-Wilsall 161-kV 3) Clyde Park-Bozeman "B" 161-kV 4) Tie line 161-kV Three Rivers to Renova	None	9.0	.961	0.0	1.072	.2	1.071	Voltage at Madison .964 P.U.; Renova .977 P.U.
8.	1) Clyde Park-Wilsall	None	7.7	1.008	.5	.87	1.4	.884	Bozeman-Big Sky 69-kV voltage at Bozeman Hot Subs 1.05 P.U.
9.	1) Clyde Park-Wilsall 161-kV 2) Clyde Park-Bozeman 161-kV "B" 3) Ennis-Big Sky 161-kV 4) Ennis-Bozeman 161-kV 5) Ennis-Dillon 161-kV 6) Clyde Park-Tom Minor 161-kV 7) Tom Minor-Chico 69-kV 8) Tom Minor-Gardner 69-kV	None	15	1.033	.6	1.054	1.7	1.068	Bozeman-Big Sky 69-kV; voltage at Bozeman Sub 1.05 P.U.

Table 3-15 (continued)

No.	Transmission Lines Added In Existing System	Transmission Lines Removed (or Open) From Existing System	Big Sky		Substation At Thumb		Substation At Old Faithful		Remarks
			Load In MW	Voltage In Per Unit (P.U.)	Load In MW	Voltage In Per Unit (P.U.)	Load In MW	Voltage In Per Unit (P.U.)	
10.	1) Clyde Park-Wilsall 161-kV 2) Clyde Park-Bozeman 161-kV "B" 3) Ennis-Big Sky 161-kV 4) Ennis-Bozeman 161-kV 5) Ennis-Dillon 161-kV 6) Clyde Park-Tom Minor 161-kV 7) Tom Minor-Chico 69-kV 8) Tom Minor-Gardner 69-kV	None	30	.979	0	1.075	.3	1.073	
11.	1) Clyde Park-Wilsall 161-kV 2) Clyde Park-Bozeman 161-kV "B"	None	9.0	.895	.1	1.067	.2	1.066	Bozeman-Big Sky 69-kV; voltage at Bozeman Hot Subs .952

TABLE 3-16

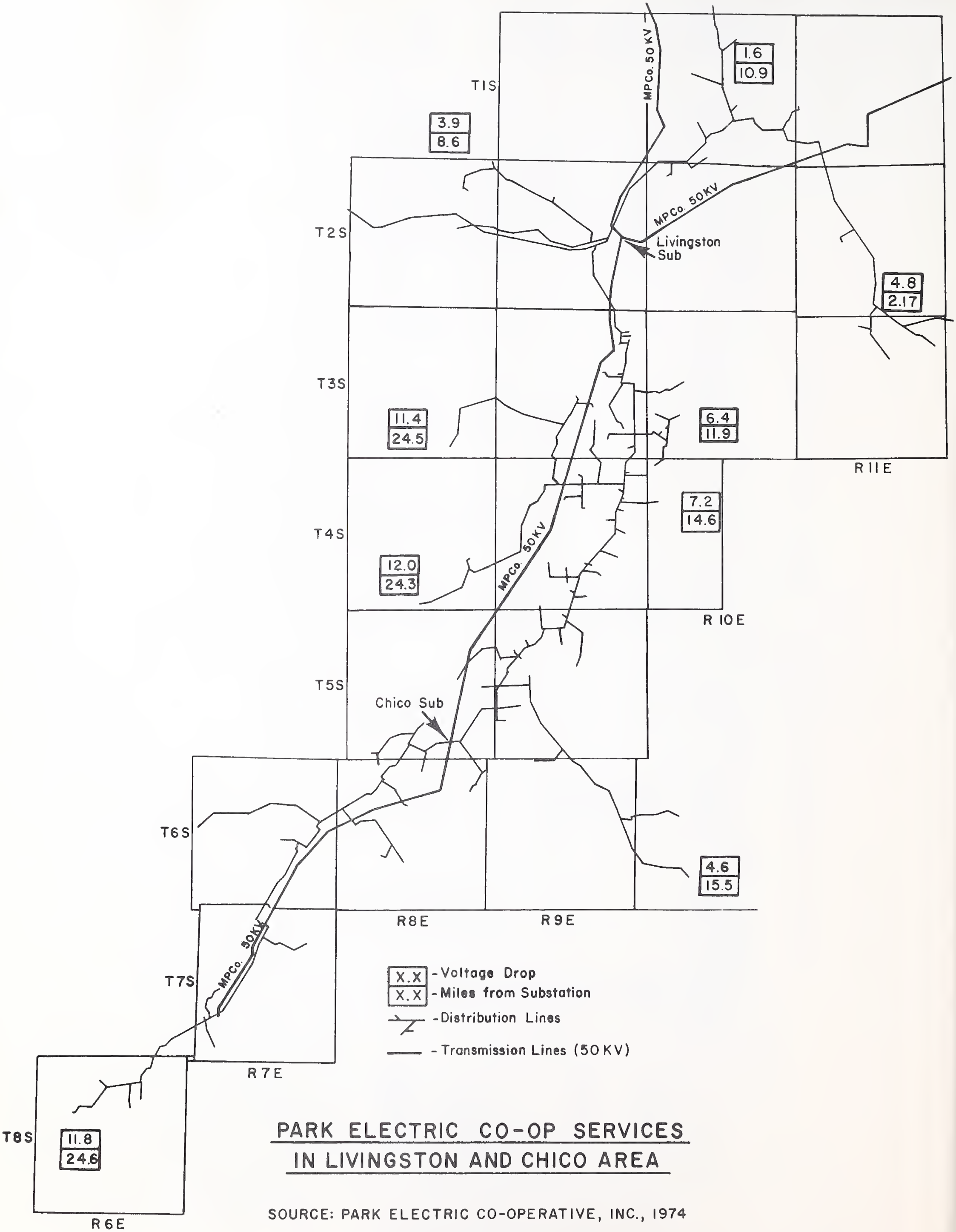
EXISTING TRANSMISSION LINES - OUTAGE DATA IN HOURS

		1970		1971		1972		1973		1974	
Line	Voltage	V HR:MIN	I HR:MIN	V HR:MIN	I HR:MIN	V HR:MIN	I HR:MIN	V HR:MIN	I HR:MIN	V HR:MIN	I HR:MIN
Bozeman-Big Sky	50/69	-	-	3:55	18:30	-	20:20	-	4:17	-	21:51
Livingston-Gardiner	69	-	0:53	-	0:50	-	0:20	-	1:24	-	-
Canyon-Lake	50	-	16:59	-	14:03	-	38:17	-	18:34	-	50:03
Lake-Thumb	50	-	3:44	-	24:29	-	6:55	-	61:48	-	36:02
Madison-Old Faithful	50	-	3:55	-	11:26	-	27:45	-	30:36	-	-
Mammoth-Norris	50	-	77:00	-	42:13	-	-	-	6:00	-	94:32
Norris-Madison	50	-	77:00	-	-	-	31:22	-	-	-	35:02
Norris-Canyon	50	-	-	-	8:59	-	-	-	6:32	-	23:05
Gardiner-Mammoth	50	-	-	-	-	-	-	-	-	-	17:20
Clyde Park-Mill Cr.	161	251:49	0:02	91:04	0:04	99:55	35:14	-	4:47	6:51	0:01
Clyde Park-Bozeman	161	31:07	-	9:34	-	-	-	-	-	-	-
Billings-Mill Creek	230	28:51	7:43	396:22	0.03	32:01	2:03	1:00	14:31	14:06	-
Renova-Madison	50	8:04	46:27	71:15	53:52	57:12	81:36	23:52	38:46	103:26	70:52
South Butte-Madison	100	13:24	4:33	207:32	74:08	29:35	95:28	49:22	6:02	4:51	4:49
Total		333:15	238:16	779:42	248:37	218:43	339:20	74:14	193:17	129:14	353:37

SOURCE: Montana Power Company, unpublished data, 1975.

NOTES: Momentary outages are not included.

V = Voluntary outage; I = Involuntary outage



PARK ELECTRIC CO-OP SERVICES IN LIVINGSTON AND CHICO AREA

SOURCE: PARK ELECTRIC CO-OPERATIVE, INC., 1974

Figure 3-4

Sky is presently served by one 69-kV line; when it is out of service, the area will be without an electrical supply. The outage data given in Table 3-16 for the past three years indicates an average of 17 hours per year of outage for the 50/69-kV line. The longest involuntary outage during this period occurred on July 10, 1972, and lasted 8 hours and 45 minutes. Table 3-17 shows Bozeman to Big Sky outage data. See Appendix F for outage data for Yellowstone Park, Livingston to Gardiner, and Madison to Bozeman.

4. Bozeman Area. This area had a 1975 load of about 22 MW, but the 1976 projected heavy load for winter is about 30 MW. Ninety percent of this power is coming from the Clyde Park substation on the Clyde Park-East Gallatin 161-kV line (referred to as the Clyde Park-Bozeman 161-kV "A" line). When this line is experiencing an outage, the Bozeman area will need another source of power for reliability purposes. According to Table 3-16, no involuntary outages occurred on the Clyde Park-Bozeman 161-kV line during the 1970-1974 period. A total of 40 hours and 41 minutes of voluntary outage did occur during the same period.

TABLE 3-17

Bozeman To Big Sky Outages

	Date	Outage Time Hrs : Min		Reason
1.	8-15-71	3:10	I	Bad insulator
2.	8-17-71	1:20	V	
3.	8-19-71	0:45	V	
4.	8-20-71	1:50	V	
5.	10- 2-71	4:50	I	Tree in line
6.	10- 2-71	1:10	I	Trees in line
7.	10- 2-71	3:30	I	Trees in line
8.	10- 3-71	3:00	I	Trees in line
9.	10-31-71	1:40	I	High winds
10.	12- 6-71	1:10	I	Contractor accidently kicked out line
11.	1-11-72	3:30	I	Tree in line
12.	7-10-72	8:45	I	Contractor hit line
13.	8-22-72	2:25	I	Unknown
14.	9-26-72	5:40	I	Tree in line
15.	10- 7-73	2:35	I	Tree in line
16.	10-23-73	0:47	I	Truck hit pole
17.	12- 4-73	0:55	I	Snow Plow hit pole
18.	1-30-74	4:15	I	Tree in line
19.	3- 2-74	1:50	I	Tree in line

TABLE 3-17 - (continued)

	Date	Outage Time Hrs : Min		Reason
20.	3- 2-74	1:00	I	Tree in line
21.	3- 8-74	2:55	I	Underground dug up
22.	4-10-74	2:20	I	Phase wire down
23.	5-13-74	4:25	I	Tree in line
24.	5-12-74	1:20	I	Snow storm
25.	7-22-74	3:46	I	Trees in line

SOURCE:

NOTE: I - Involuntary Outage
V - Voluntary Outage
M - Momentary Outage

FOOTNOTES

CHAPTER THREE

1. Montana University System, Consolidated Enrollment Report (for each year indicated). Helena, Montana.

2. Montana Department of Agriculture, Montana Agricultural Statistics 1972 and 1973. Helena, Montana; December 1974.

3. Personal Interview with Mr. Vernon Blakely, President, Big Sky, Inc. August 13, 1975; see also, "Big Sky Switches to Boosting Recreation," The Independent Record, July 17, 1975.

4. Written Communication, Montana Power Company to Department, January 24, 1975.

CHAPTER FOUR

System Alternatives

4.1. Introduction

This chapter contains discussions relating to different possible power supply sources within the study area. Specifically, detailed information is provided in section 4.2. on the Madison hydro plant and the feasibility of expanding it. Section 4.3., Alternative Transmission Methods, considers the possibilities of either upgrading existing facilities in the study area or adding new lines. It also considers the alternative of employing underground transmission systems rather than the conventional overhead lines proposed by the applicant. Section 4.4. discusses specific engineering alternatives for correcting power system problems in the Upper Yellowstone Valley and Yellowstone Park, Bozeman, and Big Sky Service areas.

Current development plans of the Big Sky resort area will require more electrical energy than can currently be supplied by the area's existing facilities. Potential sources of electricity and heat are: fossil fuels (i.e., gas, coal, and petroleum products), solar, wind, and geothermal power. However, the possibility of using gas and oil as heat or electricity sources except in emergency situations is considered unfavorable because of their increasing cost and scarcity. Presently, Big Sky is not supplied by any gas or oil pipelines. Solar energy and/or wind energy used separately or together are presently available to provide power for individual dwellings, buildings, homes, etc. However, the electricity generated by these solar and wind facilities is not available all of the time, and, therefore, requires a "back-up" supply, which, in most cases, would have to come from the utility company serving that given area. Large scale commercial solar and wind generators adequate to service a complex such as Big Sky are not available at this time. Installation of solar and wind generators would be a means for reducing electrical loads at Big Sky, but it would have to be on an individual unit basis, probably at the homeowner's own expense.

4.2. Madison Hydro Power Plant

The Madison hydro plant, currently operates a hydro generator in the study area. It is located on the Madison River about 22 air miles from Big Sky. The plant was installed in 1906, and at the present time has a maximum name plate capacity of 9000 KW (9MW). Flow data for the Madison River are given in Technical Appendix G.

The following plant data were provided by the applicant in its power system statement to the Federal Power Commission:

Number of units: 4
Capacity of each unit: 2250 kW
Operating speed in RPM: 300
Generator voltage: 4000 volts
Year installed: 1906
Design water head: 100 ft

The generating capacity can vary from 5382 kW to 12,012 kW, depending upon water flow and load factor of the power plant. One way the generating capacity can be increased is to increase the value of head ("H"). To increase the value of "H" is to increase the water level of Ennis Lake. An increase of 10 feet of water level can increase the power output at a maximum of 10% which would be a maximum of 1000 kW). However, the rise in water level would cause flooding problems in the surrounding area. The normal level of Ennis Lake is about 4841 feet; raising the level to 4880 would flood the surrounding area, possibly affecting a campsite, the Harris Inn Site, and houses nearby. At the same time, the rise in water level would produce only 4 MW of energy, while the total Big Sky requirement is estimated at 32 MW. In addition, to increase the power plant capability, it would be necessary to obtain a certificate from the Federal Power Commission. Therefore, expansion of the Madison hydro power plant is not considered a practical power source alternative at this time.

The next step is to consider the existing power sources and connect them to the load area with transmission lines. This possibility will be discussed, considering the existing transmission system, and the possibility of using or upgrading the existing system.

4.3. Alternative Transmission Methods

Chapter Three has pointed out existing trouble areas and required power needs in three different service areas: Big Sky, Bozeman, and the Upper Yellowstone Valley (including part of Yellowstone Park and the Rural Electric Association). The following section describes the general practical alternatives available for transmitting increased energy for a power source to a load area, and the more specific alternatives appropriate for the above three service areas. The general practical alternatives fall into one of two categories: (1) upgrading the existing facilities, and (2) adding new transmission lines.

4.3.1. Upgrading Existing Facilities

There are three methods by which the power transmission capability of an existing overhead transmission line can be increased:

1. Increase voltage and maintain conductor size constant

2. Increase conductor size and maintain voltage constant

3. Increase voltage and conductor size

Method 1 requires that the transmission lines be revised to provide increased insulation levels. A new value of "minimum vertical clearance between conductors at mid-span and ground" must be determined in accordance with the National Electric Safety Code for the increased voltage. Therefore, it may be necessary to replace or modify existing structures. If the existing structure is also used to support other transmission, distribution, or communication circuits, these may have to be relocated to meet safety or operational requirements.

Method 2 can be accomplished by replacing existing conductors with larger conductors or by bundling a second conductor with each existing conductor. The transmission line structures must be evaluated to determine their ability to withstand the increased mechanical loadings. Also, the hardware by which the conductors are attached to the insulators must be modified or replaced.

Method 3 requires a combination of points described for methods 1 and 2.

The applicant has provided data on structures, wire size, etc., for existing transmission lines in Table 4-1.

If a decision is made to upgrade the existing Bozeman to Big Sky 69-kV line to a higher voltage level, Big Sky might be left without power during the construction period. During periods of voluntary outages, power could be supplied by oil or gas-fired generators located at Big Sky. Generators in the 5 to 8 KW capacity, range would cost about $150 per KW, and fuel heat requirements would be about 14,000 BTU/KWH. After the switch from 69-kV to 161-kV were completed, the generators could be used as an emergency back-up source of energy available whenever transmission line outages occur.

4.3.2. Addition of New Transmission Lines

If neither the existing power system nor upgrading the existing system can reasonably solve the entire load problems, the other alternative is to add more transmission lines. There are two kinds of lines: (1) D.C. transmission lines, and (2) A.C. transmission lines.

At present, because of economic considerations, D.C. lines are used mainly for large power transfers (more than 1000 MW) over long distances (more than 400 miles), and are not considered to be a practical alternative for this application.

A.C. transmission lines are used mainly for power transmission, by either underground power cable or overhead transmission lines. They are discussed separately below.

Underground transmission is accomplished by using the following types of cable:

A. High pressure oil-filled pipe type cable
B. High pressure gas-filled pipe type cable
C. Self-contained, low and medium pressure, paper insulated, oil-filled cable

TABLE 4-1

EXISTING TRANSMISSION LINE DETAIL

From	To	Volts kV	Miles	Conductor	Span Ft	Pole Length Ft	Minimum Mid Span Clearance	Under Built Circuit
Madison	Bozeman	50	36.47	1/0 Cu	117	40	23'	Yes
Madison	Ruby	50	25.50	#6 Cu		35	23'	Telephone
Belgrade Jct.	Bozeman	50	.90	C3S8	150	30	23'	Telephone
Twin Bridges	Higgins Mine	50	11.00		225	35	23'	Telephone

SOURCE: Montana Power Company

D. Extruded solid dielectric insulated cable
E. Compressed SF_6 gas insulated bus

4.3.2.1. High Pressure Oil-Filled Pipe Type Cable

In 1973 the most widely used underground transmission cable in the United States was the high pressure oil-filled pipe type. Approximately 2000 circuit miles were in operation at voltages from 69-kV to 345-kV with power transmission capabilities from 100 MVA to 600 MVA (Brooks 1973).

High pressure oil-filled pipe type cable consists of three paper insulated conductors contained in a corrosion protected steel pipe (see Figure 4-1). The integrity of the insulation is assured by filling the pipe with insulating oil and maintaining the oil at a static pressure on the order of 200 psi.

A pumping plant maintains pressure on the system and provides a storage tank for oil expelled from the pipe during heating cycles. Splices are required for every two to three thousand feet of cable (see Figure 4-2). The pipe which contains the cable is shipped in sections and welded together at the site.

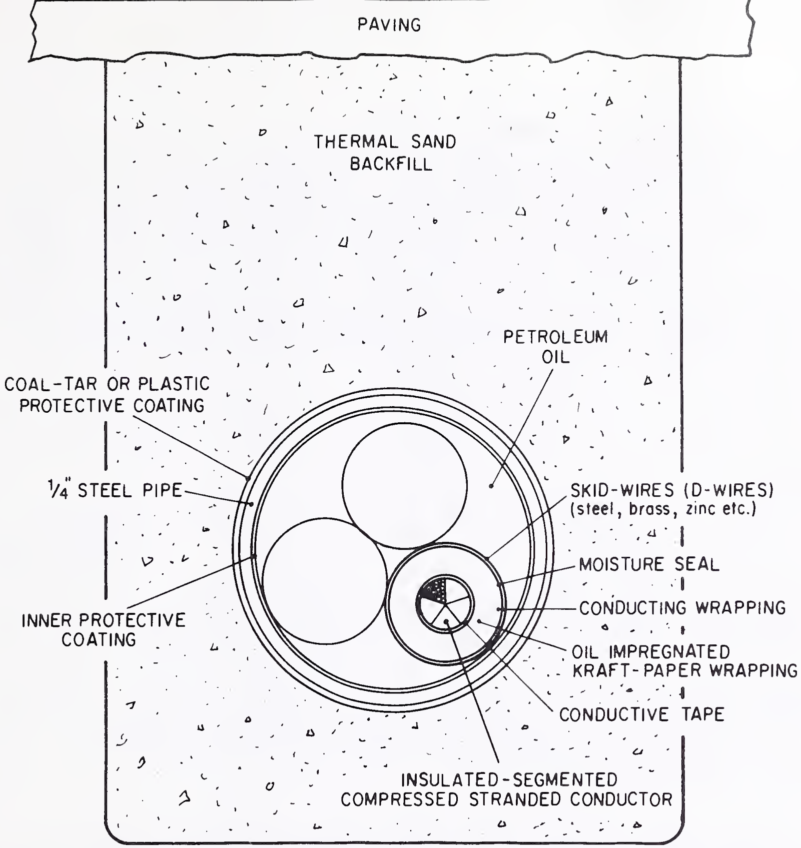
4.3.2.2. High Pressure Gas-Filled Pipe Type Cable

This type of cable is similar to the high pressure oil-filled pipe type cable, except nitrogen gas is used instead of insulating oil. With the gas type cable, there is no requirement for oil stops to prevent excessive hydraulic pressure due to differences in elevation. Also, oil pumping stations are eliminated. In place of oil pumping stations, nitrogen gas supplies and pressure regulating equipment are required.

4.3.2.3. Self Contained, Low and Medium Pressure, Paper Insulated, Oil-Filled Cable

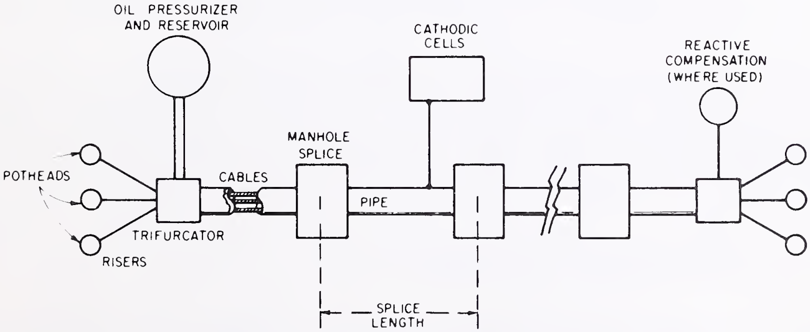
This type of cable is the oldest type of cable used for underground power transmission at voltages at 69-kV and above. The most common design is single conductor cable with a hollow core for oil feed. The paper insulation is covered with a lead sheath, and one of several types of protective coverings may be applied over the lead for various operating requirements.

The oil-filled system operates on the principle of complete exclusion of gas. Sealed reservoirs allow low viscosity oil to flow in and out as volume changes with operating temperatures. In low pressure cables without a reinforced sheath, normal operation is 10 to 15 psi. This pressure is insufficient to suppress inonization of entrapped gas by the electrical characteristics of the power line, and extreme care must be taken to exclude gas in manufacture, shipment, and insulation. The medium pressure type oil-filled cable operating at 22 to 30 psi has an advantage because the increased oil pressure acts to inhibit the formation of gas bubbles, which would cause a breakdown of the conductor.


PAVING
THERMAL SAND BACKFILL
PETROLEUM OIL
COAL-TAR OR PLASTIC PROTECTIVE COATING
1/4" STEEL PIPE
SKID-WIRES (D-WIRES) (steel, brass, zinc etc.)
MOISTURE SEAL
CONDUCTING WRAPPING
INNER PROTECTIVE COATING
OIL IMPREGNATED KRAFT-PAPER WRAPPING
CONDUCTIVE TAPE
INSULATED-SEGMENTED COMPRESSED STRANDED CONDUCTOR

CROSS SECTION OF A SINGLE-CIRCUIT HIGH PRESSURE OIL FILLED PIPE-TYPE CABLE SYSTEM

Figure 4-1



COMPONENTS OF A SINGLE-CIRCUIT PIPE-TYPE CABLE SYSTEM

SOURCE: ELECTRIC RESEARCH COUNCIL

Figure 4-2

4.3.2.4. Extruded Solid Dielectric Cables

This type of cable is manufactured by extruding a solid dielectric insulating material, usually a polyethylene derivative, around a copper or aluminum conductor. A metallic conducting shield is then placed over the insulation, and the shield is covered with a corrosion protective jacket. The result is a shielded single conductor cable of simple construction. The manufacturing process is continuous and the resulting cable is less expensive than other types of cables of the same voltage class and power capability. This type of cable is in common use today for lower voltage systems.

Manufacturers of solid dielectric cables recommend its use at voltages up to and including 69-kV. Extruded solid dielectric cable systems have been installed, on a restricted basis, and operated at voltages through 138-kV.

Extruded solid dielectric cables using cross-linked polyethylene insulation have been subjected to accelerated life tests at the Underground Transmission Test Facility at Waltz Mill, Pennsylvania. These tests were sponsored by the Edison Electric Institute and the Electric Power Research Institute (EPRI 1974), and were conducted from 1971 to 1973. The cables tested were designed for use at voltages greater than 69-kV. All cables tested experienced some form of failure. The cable failures were generally explained, but in some cases, the failing mechanism could not be identified. Additional research is being conducted by EPRI in an attempt to identify all breakdown mechanisms of cross-linked polyethylene insulated cables used at voltages greater than 69-kV.

Another type of insulating material which has been developed in recent years as an alternative to cross-linked polyethylene is ethylene propolene rubber (EPR). EPR can be spliced more easily than cross-linked polyethylene, but has not been applied at high voltages since it is still in the developmental stages.

With extruded solid dielectric cables, it is possible in certain soils to eliminate the excavation of a trench and save money by installing the cable by a plowing procedure. The mounted plow uses a rapid up-and-down oscillation to slice through the ground along its entire cutting edge like a knife. As a result, less force is required to move the blade through the soil. The resulting "slot" is clean-sided and easy to restore with less soil disturbance. As the plow blade oscillates, the cable chute maintains a constant position at the desired laying depth. The chute guides the cable into place to avoid stretching or sharp bends, thereby preventing damage to ground conditions.

4.3.2.5. Compressed Gas Insulated (CGI) Bus

This type of transmission system has been used for installations of distances on the order of hundreds of yards. The reason for the limitation is cost. For longer distances, underground high pressure oil-filled pipe type cable is less costly then CGI.

Compressed gas insulated bus offers a solution to a problem where an overhead transmission line would cross an obstacle or where a visible transmission line would be objectionable. It has been applied in cases where a new transmission line must cross over an existing transmission line, and a new overhead line would require prohibitively high towers. In these cases, compressed gas insulated bus is found to be a practical solution.

This type of transmission system consists of one bus per phase. Each phase bus consists of two aluminum tubes arranged concentrically. The inner tube is the conductor and the outer tube is an electromechanical shield. The inner conducting tube is held in place by porcelain or epoxy insulating spacers.

The conductor is an aluminum tube 4 to 6 inches in diameter, and the outer tube is an aluminum casing 14 to 16 inches in diameter. The space between the inner and outer tubes is filled with sulpher hexaflouride (SF_6) gas. The gas is maintained at a pressure of 22 per square inch (2.5 atmospheres absolute).

SF_6 gas is an insulating medium used in electrical equipment. It is highly stable, inert, non-toxic, non-poisonous, non-flammable, odorless, colorless, tasteless, electro-negative, and heavier than air.

Major advantages of SF_6 gas as a dielectric are its dielectric constant of 1.0 and low power factor, which makes it a good low-loss insulating material. For similar voltage ratings, the charging current requirement is less than that of cable and greater than that of an overhead line.

4.3.3. Application of Underground Transmission Systems

The transmission system expansion plans proposed by the applicant are all based on the use of conventional overhead transmission lines. This approach is the standardly-accepted engineering method of dealing with the problems of estimated load growth, and is also the least costly in terms of first cost, which is mainly the cost of material and construction.

The use of alternatives to overhead transmission lines by electric utilities has been increasing in recent years. Presently, the decision to use an alternative cannot be justified by economic comparison based on first cost of equipment, labor for installation, and annual expenses; rather, the decision is made on the basis that there is some other compelling reason that an overhead transmission line cannot be used. As the selection and comparison processes of transmission system rights-of-way becomes more sophisticated, and other factors affect the economics of overhead A.C. transmission, it may become possible to justify the use of alternatives to overhead transmission lines.

Following is a summary of the application of each of the alternatives. The line length is kept open, depending upon where undergrounding is necessary.

TABLE 4-2

BASIC ELECTRICAL CHARACTERISTICS AND ADDITIONAL DATA FOR ALTERNATIVE TRANSMISSION LINE SYSTEM

Manufacturer and type transmission system	Phase to phase rated voltage kV	Effective A.C. resistance at operating temperature ohms/phase/mile	Series Inductive reactance at 60 hz ohms/phase/mile	Shunt Capacitive reactance at 60 hz ohms/phase mile	Conductor size kc-mil and material	Cable outside diameter inches	Power Rating Underground Installation MVA	Ampacity	Insulation type	Total losses at full load MW/mile	Estimated material cost dollars per three phase mile[1]
Okonite 3/c Oil Filled Type Cable	115	0.434 @ 90°C	0.2365	7,783	250 Aluminum	3.73	52	261	Paper & Oil	0.0417	$ 80,000
Okonite 1/c Gas Filled Pipe type cable	115	0.555 @ 85°C	0.308	8,558	212 (4/0 AWG) Aluminum	1.76	46	231	Paper and Nitrogen	0.121	$ 40,000[2]
Okonite Solid Dielectric 1/c Insulation	115	0.419 @-55°C	0.445	15,772	250 Aluminum	2.7	66	331	Cross linked polyethylene	0.0786	$156,000
Kaiser 1/c Solid Dielectric Insulated	115	0.294 @ 50°C	0.413	Not Available	350 Aluminum	2.71	58	288	Cross linked polyethylene	0.0053	$125,000
I.T.E. Imperial compressed SF gas insulated bus	138	0.063 ---	0.105	24,000	4.25 inch dia. tube aluminum	10.0	240	1000	SF_6	9.61 kW at 40 MW load	$1,320,000

---

[1] Estimated material cost per three phase mile (for budget purpose, not a formal quote) excluding civil works, compensation equipment, and pumping station.

[2] Cost of 5" diameter pipe not included.

1. High pressure oil-filled pipe type cable, and self-contained low and medium pressure paper insulated oil-filled cable can be considered as alternatives to 100-kV and 161-kV overhead transmission lines.

2. High pressure gas-filled pipe type cable can be considered as an alternative to 100-kV and 161-kV overhead transmission lines.

3. Compressed SF_6 gas insulated bus can be considered for distances on the order of hundreds of yards as an alternative to overhead transmission lines at voltages greater than 69-kV.

4. Extruded solid dielectric insulated cable can be considered as an alternative to 50-kV and 69-kV overhead transmission lines.

To determine the engineering feasibility of one of the underground transmission systems, it is necessary to:

1. Determine the sections of the route to be replaced by an underground transmission system

2. Determine the length of the sections

3. Establish requirements for substations at each end of the section

4. Determine the maximum amount of power which must be transmitted

5. Determine conductor sizes to be considered

6. Obtain electrical characteristics for the alternate transmission system

7. Using an equivalent circuit and the electrical characteristics of the preceding steps, make load flow calculations to determine:

    a. Ability to transmit required amounts of power
    b. Ability to operate within acceptable voltage limits
    c. Need for shunt reactors at sending and receiving end substations

8. If necessary, test system for stability problems

Manufacturers of cables for transmission systems were contacted and asked to submit data which could be used as a starting point in a study of the use of the alternatives. The basic data are presented in Table 4-2. The material cost can vary from $80,000/mile to $1,320,000/mile for underground transmission. For overhead line construction the applicant has provided an average cost of $29,000/mile for the 161-kV line, and $18,000/mile for the 69-kV line. From this discussion, it can be seen that underground transmission should not be ruled out if for some compelling reason the added expense could be justified.

4.4. Specific Transmission Alternatives

Alternatives are discussed below for three locations within the study area which have power system problems.

4.4.1. Upper Yellowstone Valley and Yellowstone National Park

The Yellowstone Park and Valley areas are now served by one radial line from Livingston. Both the Park Electric Cooperative service area in the Upper Yellowstone Valley and Yellowstone National Park currently experience voltage drops in excess of the Public Service Commission's regualtions. The engineering analysis indicates three possible solutions for this problem. One would be the construction of an additional transmission line from Livingston or Clyde Park (which is one source of power for Livingston); the line could be 69-kV or 161-kV, as both voltage levels are readily available. Excluding the Dillon area, the Clyde Park substation is the only practical power source for the Upper Yellowstone Valley and Yellowstone National Park. Although it would provide some potential increase in service reliability, the alternative of connection with Dillon is not suggested by the applicant (see section 1.2. in Chapter One).

The second alternative would be construction of local generation in Yellowstone Park; however, because of the special nature of a national park, this may not be practical unless special studies are conducted. The applicant currently has a diesel generator at Lake in Yellowstone Park. According to the applicant:

> The diesel generator is operational and is used only when outages occur on the transmission system serving Yellowstone. The generator does not have capacity enough to serve the entire Yellowstone Park electric load during peak demand conditions.

The third possible solution to the voltage drop problem would be the upgrading of the existing transmission line to a higher voltage, either 69-kV or 161-kV. However, this alternative would require the installation of voltage transformers at each of the four distribution points at which the existing line is now tapped. The four transformers and associated equipment could cost on the order of one million dollars. This cost would be in additon to the cost of rebuilding the lines (e.g., erection of new poles, stringing new conductors, etc.) at the higher voltage level.

4.4.2. Bozeman Service Area

The engineering load flow study indicates that the Bozeman area now receives 90% of its electrical power on one 161-kV line from Clyde Park. An alternative to this heavy reliance on one line would be the construction of a new 161-kV line from Bozeman to either Clyde Park or the Trident area (the Three Rivers substation).

According to the engineering study results, connection with the Billings-Anaconda 230-kV line at either the Clyde Park substation or the Three Rivers substation (near Three Forks) would be an acceptable power source for the Bozeman area. Connection at the Clyde Park substation would be advantageous in that 230-kV to 161-kV transformation is now in existence, but disadvantageous in terms of reliability because both the new and existing 161-kV lines would originate at the same point and would therefore rely upon the same energy source. Connection at Three Forks substation would create a second power source for Bozeman, but would require installation of 230/161-kV transformation. The distances from Bozeman to the two substations are approximately equal, as the Clyde Park substation is located 28 miles to the northeast and the Three Forks substation 31 miles to the northwest.

4.4.3. Big Sky Service Area

As was discussed in Chapter Three, the continued development of Big Sky will result in increased requirements for electrical energy. However, the exact timing of the future development is difficult to forecast accurately. The following alternatives are available to meet the projected long-term demand at Big Sky:

1. Installation of a 161-kV line from Bozeman to Big Sky (either by upgrading the existing 69-kV line or by constructing an additional line)

2. Construction of a 161-kV line from Dillon to Big Sky

Both of these alternatives include a line at a 161-kV voltage level because at 161-kV, the energy losses in the transmission line would be less than at any lower voltage capable of supplying 32 MW of load, the projected long-term full-scale development requirement; thus, the 161-kV level would conserve energy.

The existing power source for Big Sky is the Bozeman area. Power is now transmitted to Big Sky from the Bozeman-Hot Springs substation via a 69-kV transmission line routed through the Gallatin Canyon. The alternatives of routing a new 161-kV line through the Gallatin Canyon or of upgrading the existing 69-kV line to 161-kV and building no other new lines to Big Sky are feasible from an engineering viewpoint in that both could provide the projected necessary increase in power capacity. However, both alternatives would present potential reliability disadvantages, limiting Big Sky to one power source, the Bozeman-Hot Springs substation. An outage of that source would leave Big Sky without power. Also, complete reliance upon one or two lines routed through the Gallatin Canyon provides some additional risk of loss of service due to failure of the line or lines between Big Sky and the substation. As was discussed in Chapter Three, the existing Bozeman-Big Sky line experienced an average of 17 hours of outages per year (16 hours of involuntary outages per year) during the years 1971 through 1974. The average number of hours of outage at the Bozeman-Hot Springs substation was two hours during the period 1971 to 1975, and the longest single outage during the same period lasted three hours and twenty minutes.

The other alternative for supplying Big Sky would be a line connecting Big Sky to Dillon with an intermediate connection in the Ennis area. The Dillon area receives its power from the Anaconda-Butte area, which in turn receives its power from three different sources to the east, north, and west depending upon existing load conditions. Connection with Dillon would provide a second independent source of energy, thereby increasing service reliability.

Connection of Big Sky with Dillon in the Ennis area would also permit interconnection with the Madison hydro plant, which is located about 11 air miles from the city of Ennis. The Madison hydro plant could provide up to 5 MW of power to Big Sky in an emergency situation in case Big Sky were isolated from the Bozeman and Dillon power sources.

If the decision is made to connect Big Sky with Dillon via a route through the Ennis area, consideration may be given to constructing a 161-kV line from Ennis to Bozeman in order to increase the reliability of service at Big Sky in the event of an outage on the Dillon to Ennis portion of the line. Until the load at Big Sky exceeds about 17 MW, the extra reliability afforded by the Ennis to Bozeman link would not be necessary, as the existing 69-kV line and the Madison hydro plant together could provide about 17 MW to Big Sky. As the applicant's load projections for Big Sky are not predicted to exceed 17 MW until the 1977-1978 winter season, a decision to complete the Ennis to Bozeman link need not be made now. Observation of actual consumption at Big Sky could provide a check of the load projections so that the time period in which the potential increased reliability afforded by the Ennis to Bozeman line would become significant could be more accurately predicted. If this line segment is deemed necessary, the existing 50-kV line from the Madison hydro plant to the Bozeman south side substation could be replaced by a 161-kV line. By not constructing the Ennis to Bozeman line now, the power company would defer a capital investment of about $1,334,000 (46 miles of 161-kV line at $29,000 per mile).

An acceptable engineering alternative to supplying reliability at Big Sky via the Ennis to Bozeman line would be the upgrading of the existing 69-kV line through the Gallatin Canyon to a 161-kV line.

CHAPTER FIVE

Engineering Design Criteria/Specification and Impact Magnitude Analysis

5.1. Introduction

This chapter examines certain engineering characteristics of the proposed facility to be considered for corridor selection. The chapter begins with a description of the proposed facility and its specifications in section 5.2., followed by the proposed construction methods in section 5.3. Section 5.3. also presents cost figures related to the use of helicopters during construction of the transmission line to minimize the number of access roads created. Section 5.4. addresses electrical characteristics and impact, including problems such as corona and radio interference.

5.2. Description of Proposed Facility and Specifications

The applicant's proposed corridor location, substation site and alternative sites are shown in Chapter One. Technical and design data supplied by the applicant are listed below.

Length of Line:

1) Clyde Park to Emigrant - 39 miles
2) Clyde Park to Bozeman to Ennis - 52 miles
3) Dillon to Big Sky - 72 miles
4) Emigrant to Gardiner - 25 miles (69-kV)

Voltage Level: 161-kV (161,000 volts) - lines 1 to 3

Total Right of-Way Width: 80'

Transmission Line Poles:

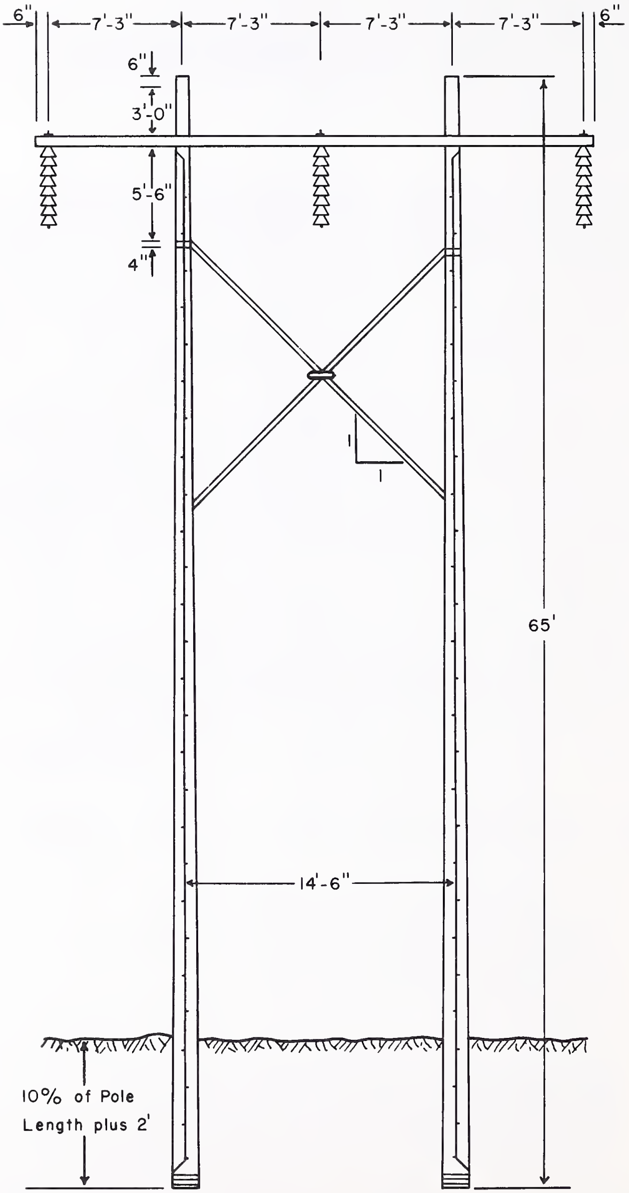
"H" type structures (see Figure 5-1)
Single pole structures (see Figure 5-2)
Foundation: approximately 8'
No. of poles per mile: 7 or 8

Transmission Line:

Conductor size: 0.927" (556.5 MCM-ASCR)
Minimum ground clearance: 29'
Insulators: 6 or 7, 10" diameter, high strength steel
Ground wires: two, 3/8" diameter, high strength steel

For 69-kV Line: (Emigrant to Gardiner - 25 miles long)

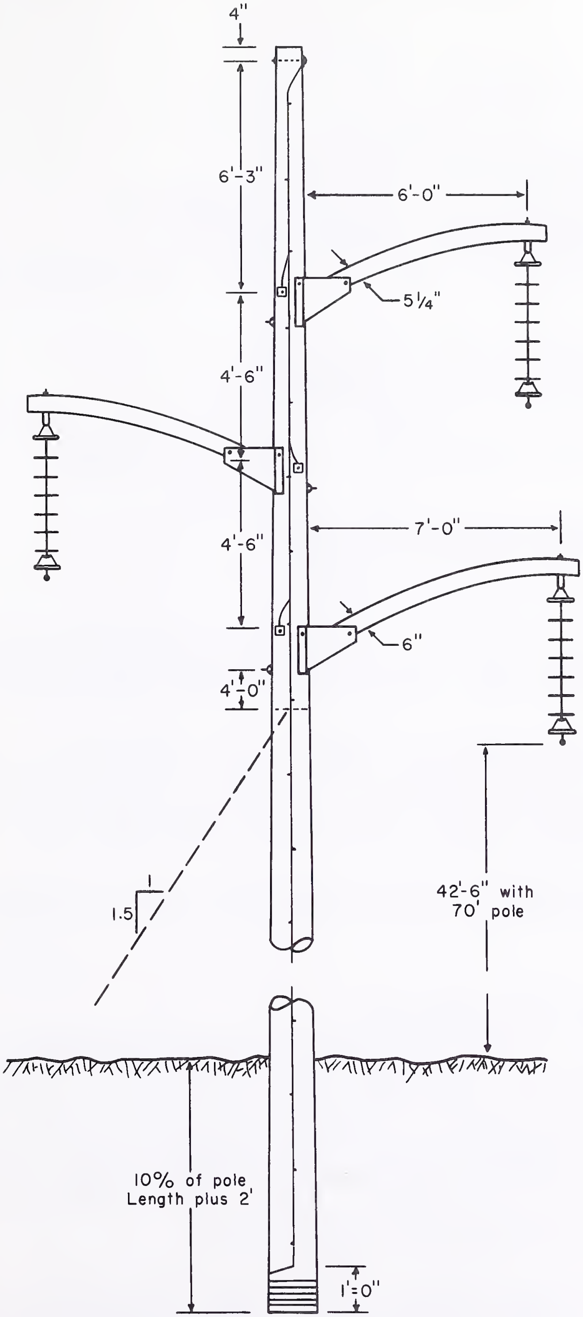
Right-of-Way: 60'



161 KV LINE SINGLE CIRCUIT STRUCTURE

SOURCE: MPC 1974

Figure 5-1



161 KV TANGENT-SINGLE CIRCUIT

SOURCE: MPC 1974

Figure 5-2

Single Pole Structures (see Figure 5-3):

Foundation: approximately 6.5'
No. of poles per mile: 7 to 9
Conductor size: 0.721" (336.4 MCM ASCR)
Minimum ground clearance: 24'
Ground wires: one, 3/8" diameter, high strength steel

Cost:

$29,000 per mile of 161-kV line
$18,000 per mile of 69-kV line
Substation cost figures are not provided by applicant

Construction crew will be 30 persons for 20 months.

5.3. Proposed Construction Analysis

5.3.1. General Proposed Procedure

Construction activities will include access road construction, right-of-way preparation, erection of structures, stringing of conductors, and cleanup and site restoration. The applicant's proposed construction schedule for the facility is:

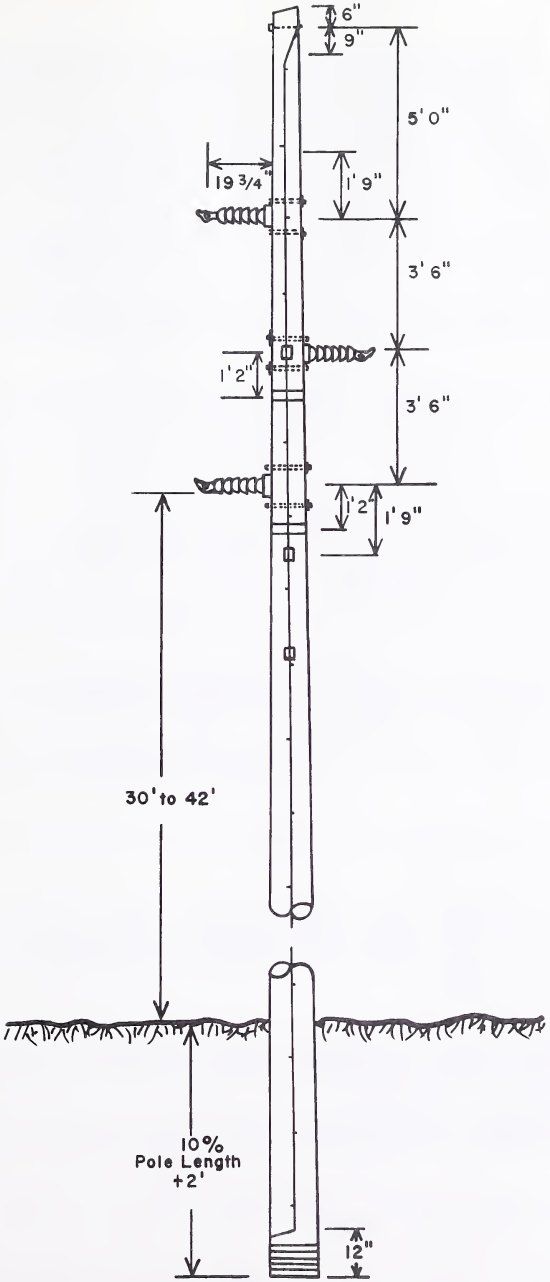
a. Dillon to Big Sky - March 1, 1976, to October 30, 1976
b. Clyde Park to Emigrant - September 1, 1976, to May 30, 1977
c. Emigrant to Gardiner - September 1, 1976, to May 30, 1977
d. Bozeman to Ennis - March 1, 1977, to October 30, 1977

The estimated size of the construction crew for the 20-month period outlined above between March 1, 1976 and October 30, 1977 will average approximately 35 persons.

5.3.2. Helicopter Construction

Helicopters can and have been used in the construction and maintenance of transmission lines. The extent of helicopter use on a given line varies according to the needs of the contractor or utility. Helicopters can be employed to reduce costs, to reduce environmental impacts, or both. Access roads used in construction can be kept more primitive if some of the larger pieces of construction equipment (such as cranes) can be placed by helicopters. It is also possible to completely eliminate access roads if helicopters are used to their fullest extent.

To minimize the number of access roads created during construction of transmission lines, the use of helicopters is becoming popular. Mr. Dale Doobesh, Vice-President of Sales, Imperial Air Ways Incorporation, St. Paul, Minnesota, has provided the 1975 cost figures presented in this section, and other detailed information.



69 KV HORIZONTAL INSULATOR TANGENT
STRUCTURE TYPE SAHP

Figure 5-3

The sky crane S-64, presently used by many contractors who construct transmission lines, costs $3,500 per flight hour. It can carry a load of 18,000 pounds at sea level, and load carrying capacity will decrease as altitude increases. For example, at 9,000' it will carry a load of about 10,000 pounds. The cost is $500 per day when the flight is cancelled due to weather conditions or at the contractor's request. This charge can be reduced or eliminated, (depending upon length of project or any special conditions), and can be negotiated. The helicopter company will send a pilot and two signal persons at no extra cost. The contractor has to provide two or three persons to carry structures and 4 or 5 persons at the foundation or location of the structure. A minimum of 7 hours of flying time is required, depending a great deal upon weather conditions.

Pre-planning of moving the construction crew is a vital factor. Specific application of 161-kV woooden pole "H" frame structures at an average of 6,000' altitude and an average weight of 3 tons can be accomplished by helicopter at a rate of about 50 wooden poles a day, or $490 per pole. This figure is only for budget purposes; many variables can affect the cost. According to Mr. Doobesh, there will be another type of helicopter available in January 1976 to be called Bell-214, which will be more efficient and economical. The cost will be $1,500 to $1,800/per flight hour, and the helicopter can carry 11,000 pounds at sea level. At the same altitude and weight mentioned above, this new type of helicopter may involve an installation cost of $210/per pole.

The above cost figures should be considered and compared to the cost of constructing lines by the traditional method of preparing access roads. At this time, the Department does not have information about length and location of required access roads, as these very much depend upon center-line location.

5.3.3. Proposed Access Roads

The applicant contends that specific access roads cannot be located until a center-line is established. However, the following guidelines for construction have been established by the applicant for access roads (MPC, Clyde Park to Dillon application).

a. Access to the right-of-way will be at designated locations along public roads. Exceptions, when required, will be negotiated by Montana Power Company.

b. Existing access roads will be utilized where possible and not in conflict with environmental objectives.

c. Existing roads, culverts or bridges, public or private, used for right-of-way access will be:

    1. Reviewed by Montana Power Company prior to use by the contractor

2. Maintained by the contractor so as not to hinder or prevent use by the owner or tenant

3. Restored to pre-use condition if damaged by the contractor

d. New access from public ways and along the right-of-way:

1. Will be at predetermined locations only

2. Will be restricted to a minimum

back to back oblique angles to minim

3. Will be constructed to preserve natural vegetation and minimize soil erosion

4. Will be designed and constructed to minimize its visibility from public roads along the right-of-way

e. Contractors' movements will be:

1. Prohibited across or near the banks of flowing creeks and streams to preserve vegetation and avoid future erosion

2. Crossing minor streams at specified locations only

3. Limited along the right-of-way in areas visible from public areas, highways and developed areas to preserve the integrity of existing trees, shrubs, ground cover and topsoil

5.3.4. Proposed Right-of-Way Preparation

In the application for the proposed facility, the applicant has stated that the following procedures will be followed in relation to right-of-way preparation.

> Clearing for roads and right-of-way in shrub areas shall be limited to crushing rather than uprooting brush. Plants may be clipped off at ground level, leaving roots undisturbed so that they may resprout.
>
> Where centerline clearing is allowed, it shall be limited to the cutting of trees which will interfere with operation of the line. In valleys where the wires would touch the tree tops during stringing, clearing shall be for a width of 10 feet on each side of the outer phase conductor positions if the trees create difficulty during tension stringing operations.
>
> Scalping of the earth or any unnecessary disturbance will not be allowed on any clearing, except in rocky areas, or on slopes where cuts and fills are necessary.
>
> No timber shall be cut or destroyed without first obtaining a permit from the appropriate owner. All timber cut, injured or

destroyed in the construction of the transmission line shall be paid for at current stumpage rates.

Trees which are felled shall be cut within 12 inches of the ground. Stumps need not be removed unless conflict with a structure or guy anchor is involved.

On some sensitive lands, hand clearing may be necessary. This will be determined on a site-by-site basis.

Between structures where no traffic is required, vegetation shall be selectively cut to remove any interference with the conductors. Wherever appropriate, selective clearing will be done to produce curved or wavy boundaries. There shall be no removal of grasses or shrubs except as required for the pulling line.

Leveling at the structure site shall be limited only as necessary for positioning equipment.

Unless shrubs and trees within the construction area interfere excessively with equipment movement during construction, such vegetation will not be removed but will be marked for preservation.

In areas of over 4% sideslope, roads, if required, shall be constructed to a 4% outslope. The roads shall be constructed so that material will not be accumulated in one pile or piles. The materials will be side-cast as construction proceeds and will not be side-cast so as to make a windrow on the downhill side.

No cutting and filling shall be allowed in areas of 4% sideslope or less.

Clearing for roads and right-of-way adjacent to streams shall be held to a minimum to reduce the potential for sediment entering these streams.

Roads shall cross drainage bottoms at right angle and level with the stream bed gradient whenever possible.

Blasting shall not be done in streams or near streams without adequately protecting the stream for debris.

All fences crossed by this power line shall be provided with a gate not less than 12 feet wide. All fences crossed by the line or access roads shall be "H" braced before the fence is cut.

5.3.5. Proposed Erection of Structures

The applicant has specified in its application that the following procedures will be applied to the erection of structures.

All structures will be located sufficiently away from creeks and streams to prevent erosion and disturbance to established drainage patterns. Care will be taken in placing structures along highways and public ways so as not to interfere with public safety and movement.

The wood pole structures will be transported to each site in unassembled pieces including poles, crossarms, and related braces. Excavation of the holes in which the poles will be placed will generally be accomplished with truck or tractor mounted augers. In areas containing ledge or rock, it will be necessary to use explosives in conjuction with excavating these holes.

The erection crane, which will be an 18-to 30-ton rubber-tired crane or a 190 to 300 HP crawler drawing a wagon crane, will approach the structure sites which previously dug holes and framed up structures await. The crane attaches to the structure by means of a spreader bar and winch line. The structure is then lifted clear of the ground and set into the holes. By means of ropes and pully methods, the structure obtains a plumbed position. All equipment remains attached to the structure as back-filling the holes begins by means of a backfill crawler. As the holes are back-filled, the tamps are brought into action to assure an adequate earth bearing against the structure. When the procedure has accomplished 2/3 of the back-fill, all restraining devices are removed and the crane moves on toward the next structure.

5.3.6. Proposed Stringing of Conductors

The applicant has specified in its application that the following procedures will be followed in the stringing of conductors.

An advance crew moves through the section to be strung hanging travelers to the pulling machine (steel-line pulling ropes, 7/16" to 5/8" steel rope generally) which is positioned for the pull.

The stringing crew and a crawler tractor begin to pull lines from the puller down the R/W. As each structure is arrived at, extra slack is pulled out and the pulling lines are fed up through the travelers at the structure. The operation continues until the pull lines arrive at the point (a reel length of R/W from the pulling point) where the tensioner is located.

The pulling lines are attached to the ends of the reeled conductors, and the pulling machine begins to reel in the conductors. The tension between the pulling machine and the tensioning machine is ratioed to keep the conductor airborne.

Upon completion of the conductor pull, the wire is sleeved to the previous conductor section by a sleeving crew and then brought up to the proper sag and tension by a sagging crew. Upon completion of the sag a clipping crew moves through the section removing travelers, applying armor rod and hanging the conductors in the suspension shoes.

CHAPTER SIX

Transmission Corridor Selection

6.1. Study Area Selection

A geographic area large enough to include all reasonable routes for the proposed transmission line project between Clyde Park and Dillon has been chosen for the study area, including the preferred and alternative routes specified by the applicant (see map entitled "Applicant's Requested Routes" in Chapter One). Existing transmission lines in the study area were also considered as possible sources of electrical power.

The study area covers approximately 6460 square miles, and is shown on Figure 2-2 in Chapter Two. It includes areas of Montana located in Park, Gallatin, Madison, and Beaverhead Counties, and portions of the Gallatin and Beaverhead National Forests, including particular areas in and around Gardiner, Yellowstone Park, and Big Sky.

6.2. Identification of Concerns

Identification of Environmental Elements Related to Each Concern

As Chapter Two pointed out, criteria used for corridor selection vary from region to region, depending upon the characteristics of the natural and cultural environments of the study area. The following concerns have been generated for the Clyde Park-Dillon project. The selected corridor shall ideally have:

1) Least risk for stream sedimentation
2) Least impact on range biomass productivity
3) Least impact on biomass (wood) productivity in forest land
4) Least impact on terrestrial fauna
5) Least cost of construction and maintenance
6) Greatest reliability
7) Least impact on existing land use
8) Least visual impact

The process used to identify and utilize the above concerns to select a corridor is explained in detail in section 6.4. at the end of this chapter.

Chapter Two explained that a set of environmental elements is needed in order to select a corridor that will fulfill the requirement of each concern identified above. Figure 6-14 in section 6.4. displays a matrix showing environmental concerns and their corresponding elements. The elements are grouped according to the following map categories, some of which are computer composites of several single maps (see section 6.4. for an explanation of how the map categories were derived).

Slope Stability Hazard Map

Highly Unstable
Moderately Unstable
Generally Stable
Quite Stable

Soil Erodibility

Very High
High
Moderate
Low
Negligible

Road Construction Suitability of Soils

Very Poor
Poor
Fair
Good
Very Good

Vegetation Recovery Rate

Very Slow
Slow
Moderate
Rapid
Very Rapid

Potential Range Productivity

Very Low
Low
Moderate
High
Very High

Slope

>60%
45-60%
30-45%
10-30%
5-10%
0-5%

Fault Hazard Zone

Fauna

Grizzly Bear
Elk General Winter Distribution
Elk Severe Winter Distribution
Elk Calving
Mule Deer General Winter Distribution
Mule Deer Severe Winter Distribution
Moose Winter
Mountain Goat
Bighorn Sheep Winter Distribution
Bighorn Non-Winter and Lambing
Sage Grouse Winter Distribution

Potential Forest Productivity

Very Low
Low
Moderate
High
Very High

Existing Land Use Site Patterns

Urban Areas
Small Communities
Scattered Built-Up
Irrigated Land
Dry Cropland
Wild Hay Land
Grazing Land

Existing Land Use - Linear Patterns - Transportation

Interstate Highways
Paved Roads
Graveled Roads
Unsurfaced Roads
Primitive Roads

Existing Land Use - Linear Patterns - Transportation - (continued)

Designated Trails
Railroads
Airports

Specially Managed Areas

Primitive Areas
New Study Areas (USFS)
Citizen Proposed Study Areas
Non-Selected Roadless Areas
Game Management Areas
State Recreation Waterways

Recreation

State Parks
Campgrounds
Fishing Access Sites
Picnic Areas
Highway Rest Areas
Fairgrounds
Ski Areas

Potential Land Use - Historic and Archaelogic

Subdivisions
Archaelogic Sites
National Register Sites
State Historic Sites
Ghost Towns

Visual Analysis - Visual Character

Maximum Alteration
Altered Landscape, Human Dominance
Altered Landscape, Natural Dominance
Little Alteration
Mixed Degree of Alteration

Visual Analysis - Expectation

High
Medium High
Medium Low
Undifferentiated

Visual Analysis - Frequency

High - 2000+
Medium High - 500-2000
Medium Low - 100-500
Low <100

Existing Land Use - Linear Patterns - Utilities

230-kV
161-kV
100-kV
69-kV
50-kV
Natural Gas Pipelines
Substations
Power Plants

6.3. Study Area Inventory and General Impact Evaluation

6.3.1. Introduction

Chapter Two mentioned that a multidisciplinary approach was used to produce this draft environmental impact statement. The sections which follow contain the study area inventories and general impact evaluations for the various disciplines within the natural and cultural environments. The natural environment is discussed first, in section 6.3.2. Topics within the natural environment include geology (6.3.2.2.), soil (6.3.2.3.), vegetation (6.3.2.4.), fauna (6.3.2.5.), and meteorology (6.3.2.6.). The cultural environment includes land use (6.3.3.2.), economy (6.3.3.3.), sociology (6.3.3.4.), and aesthetics (6.3.3.5.).

In general, each section is divided into three parts. Part I of each section is an introduction, part II contains the study area inventory, and part III describes the general impact evaluation, sometimes including mitigating measures. Any deviations from this format are explained in the introductions to each section.

Twenty-four maps have been prepared for the inventory write-ups in this publication, most of which have been included as foldouts within the appropriate sections of the text. However, a few were too large to insert into the text, and have been placed in a pocket on the inside back cover of this publication. These are the slope map (section 6.3.2.2.), vegetation types map (section 6.3.2.4.), soil association map (section 6.3.2.3.), and the existing land use/linear patterns - transportation map (section 6.3.3.2.).

6.3.2. Natural Environment

6.3.2.1. Introduction

A transmission line affects the natural environment in a number of ways. The kind and severity of the effects (impacts), both good and bad, for a given line depend upon the configuration of the line (e.g. voltage, type of support structures, and other engineering characteristics), construction methods, and the natural environment through which the line passes. Potential impacts of a line include sedimentation of surface waters, soil erosion, changes in vegetation, and effects on all kinds of wildlife. Conversely, the natural environment affects the line through added cost of construction and maintenance and reduced reliability. To choose a corridor which would minimize adverse impacts to the natural environment and adverse effects to the line *by* the natural environment, those relevant parameters must be understood and inventoried.

Relevant portions of the natural environment include aspects of geology, soils, climate, and biology. Not all divisions of each discipline are relevant and the evaluation of certain issues requires input from more than one discipline. For example, the risk of sedimentation in streams requires input of geologic data, soils data, and vegetation data. Conversely, not all geologic data are relevant (e.g. fossil distribution). The following sections are not meant to be monographs in their respective areas of knowledge, but rather should be adequate discussions of those areas which are relevant in assessing potential impacts of the proposed transmission line.

6.3.2.2. Geology

I. Introduction

The geologic environment and geologic processes affect all other aspects of the physical and social environment in which we live. Geologic materials and processes produce mountains, plains, rivers, and shorelines. Weather patterns are influenced by the physiographic configuration, which in turn partially determines the vegetation, soils, and animal life in a given area. Man's settlement patterns, life styles, and culture have evolved in response to the biotic and inorganic resources which are available to him. Although man has evolved around geologic patterns, some parts of which are essentially static (when viewed from a time perspective of only thousands of years), certain geologic processes are of great concern over a period of time in which he is capable of planning. For instance, the Madison Range can be viewed as an eternal entity in planning for the next century, but a given slope may be the site of landsliding within a few years -- especially if disturbed in some way.

In the discussion that follows, four geologic conditions have been inventoried for the Clyde Park-Dillon study area: physiography, slope, stratigraphy (seven stratigraphic units have been identified for the study area), and seismicity. Section III, General Impacts and Constraints, identifies five geologic concerns to be considered in routing a transmission line: physiographic constraints, slope stability, foundation problems, hydrologic problems, and seismicity.

Geologic conditions and processes should be taken into account in the planning of a transmission line to ensure the line's greatest reliability and least cost. The identification of those parameters which are relevant to these goals is problematical. Geologic hazard maps have been produced for selected areas of the United States and would be most useful in transmission line siting. However, geologic hazards range in scale from thousands of square miles to a few square feet, and include such phenomena as earthquakes, landslides, wet ground, and ground subsidence. To map all geologic hazards would require a series of maps, each one depicting a few related kinds. However, the identification of many kinds of hazards requires a good understanding of the geological conditions and processes which produce a given hazard at any location. Identifying some hazards requires a minimum of information, whereas others require evaluation of much information, some of which may be difficult or expensive to obtain. Likewise, the scale and desired certainty of the map affect the selection of the approaches which must be used. For instance, a given formation may be known for its tendency to produce landslides where it is exposed on slopes. This fact does not mean that it always or nearly always fails, but that it is more likely to fail than some other formations. If we wish to build a dam across a valley where the formation is exposed on the valley walls, it is not sufficient to know that the formation sometimes produces unstable slopes. The important knowledge in this case is whether those particular slopes by the proposed dam will or will not fail if the dam is built. To obtain that knowledge, engineering tests must be performed, and an accurate understanding of the geologic conditions unique to that site must be gained. The intensity required for this level of investigation would be impossible over a large area.

Geologic hazard evaluation at a generalized level of certainty can be accomplished over a large area, but its limitations must be understood. Within reasonable lengths of time and the finite resources available, it is impossible to generate a detailed map showing the pertinent geologic hazards over an area of two or three square degrees (over 3300 square miles per square degree at this latitude). If a month of field work (an abbreviated amount of time) were devoted to each 15-minute quadrangle, one two-degree sheet (a topographic map of an area of one degree latitude and two degrees longitude) would require 32 months in the field, or approximately a five- to ten-year period (assuming a three- to six-month field season). Therefore, any geological approach must rely heavily upon existing data.

Large study areas, such as the Clyde Park-Dillon area, are not covered by geologic maps in a uniform treatment except by the state map, which is old and of small scale. Geologic maps vary in several ways:

1. Scale
2. Materials or features which are mapped
3. The geologist's perceived purpose of his map

Two maps of the same area, one at 1:24,000 scale and one at 1:250,000 scale, would not portray the area in the same manner. Similarly, a bedrock geology map is different from a glacial geology map. In these cases, two different things are being mapped. The purpose of a map influences what is included or left out of the final product. If the map is meant to be of use to engineering geologists and land use planners, it may be quite different from one to be used by economic geologists.

II. Area Inventory

II.A. Physiography

The Clyde Park-Dillon study area lies in southwestern Montana adjacent to Yellowstone National Park. Except for the extreme eastern portion, the area lies in the northern Rocky Mountain physiographic province (Fenneman 1931) and includes all or part of several mountain ranges. The extreme northeast and extreme southeast parts of the area lie in the Great Plains Province and Middle Rocky Mountain Province, respectively (Fenneman 1931).

The western and northeast portions of the area consist of a series of isolated or semi-isolated mountain ranges rising, sometimes abruptly, from broad valley floors. The southeast portion, however, is characterized by continuous mountain masses divided by the Gallatin Canyon and the Yellowstone (Paradise) Valley.

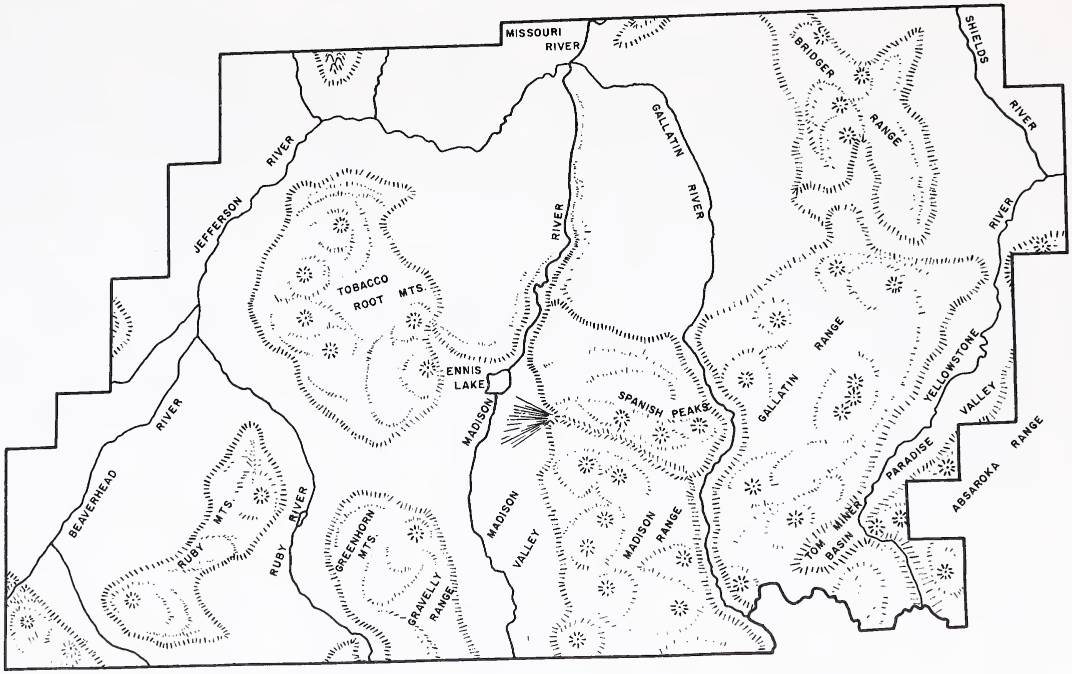
Elevations range from about 4000 feet mean sea level (MSL) where the Missouri River leaves the study area, to over 11,000 feet in the Madison Range. Relief between mountain ranges and the adjacent valleys is typically 4000-5000 feet. Local relief (on a single slope) may be as great as 3000-4000 feet.

The entire study area is drained by the Missouri River, which also originates there. The Jefferson, Madison, and Gallatin Rivers, which come together to form the Missouri, drain all but the eastern fourth or less of the area. The remainder is drained by the Yellowstone River, which joins the Missouri River near the Montana-North Dakota border (see Figure 6-1).

The valleys of the major streams typically lie in broad basin-like intermontane valleys. Notable exceptions to this generality are the Gallatin River and parts of the Madison and Yellowstone Rivers. The origin of the broad valleys is structural in many cases. The Tertiary deposits and active faults which border many valleys tell of the age and origin of these valleys.

Flood plains of the streams (used here to describe the lowest part of the valley and roughly corresponds to that area underlain by Quarternary alluvium; not the 50- or 100-year flood plains) range from about 200 feet to several miles in width. Often an escarpment separates the flood plain from the benches, which are typically underlain by Tertiary deposits. These benches are rugged in places (especially along their margins) and quite flat in others. The escarpments range from about 20 feet to several hundred feet. The escarpment along the sides of the flood plain of the lower Madison is over 500 feet high. Examples of streams which flow through valleys of this type are the lower Beaverhead River, Jefferson River, and lower portions of the Madison and Gallatin Rivers. The valleys of the Madison above Ennis Lake and the Yellowstone above Livingston share many of the characteristics of those described above.

Other valleys of major streams in the study area are quite dissimilar. The Gallatin River from Yellowstone Park to where it exits the mountains, flows through a narrow canyon with steep sides which rise 1500 feet or more above the stream. Similarly, for about ten miles below Ennis Lake, the Madison flows through a narrow gorge more than 2000 feet below the adjacent uplands. The Yellowstone flows through Yankee Jim Canyon before entering



GENERAL PHYSIOGRAPHY OF THE STUDY AREA

Figure 6-1

Paradise Valley and through another narrow gap just south of Livingston.

The mountainous portions of the study area are mostly developed upon Paleozoic and Mesozoic sedimentary rocks, Precambrian rocks, and igneous rocks (both intrusive and volcanic). The topographic form of the mountains ranges from rolling uplands to glaciated peaks. The physiographic features exist as a result of differential uplift and differential erosion, including geomorphic processes acting both now and in the past.

A sharp break in slope and lithology separate many of the mountain masses from adjacent valleys. The abrupt rise is the result of a fault in many cases. Some of these faults have had movement along them in Recent time.

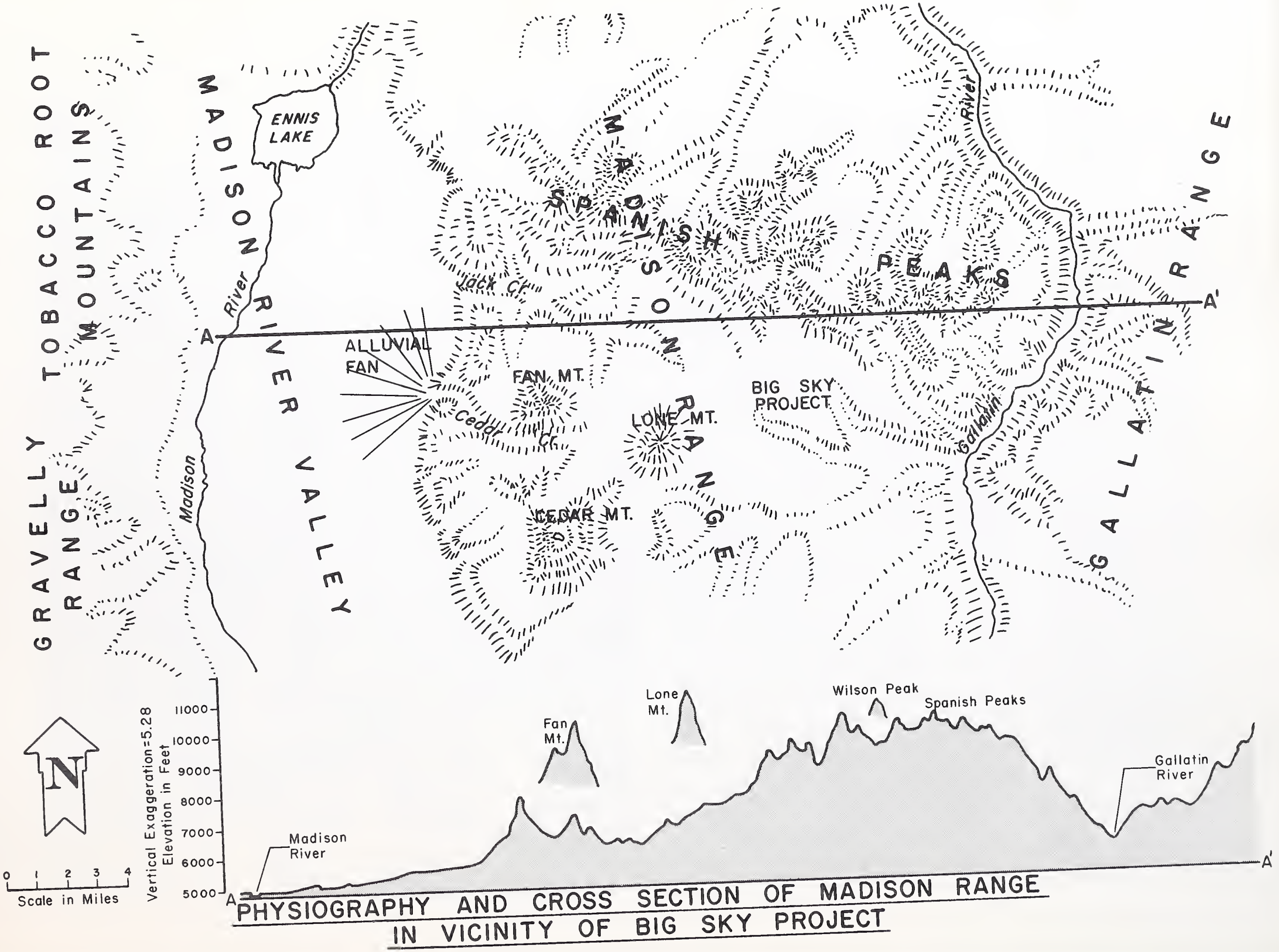
The Ruby Range, east of Dillon, rises from the basin-like valleys as an island of much older rock. Highest elevations in this range, over 9000 feet, occur at the north end where the topographic discontinuity of the mountain block is also most abrupt. The topographic axis of the range runs northeast-southwest, which is unusual for most of the Rocky Mountains. The edge of the mountain block at the northeast end is quite abrupt. Elevations in excess of 9000 feet occur within two miles of the 6000-foot level at the edge of the valley. The middle portion of the range is characterized by rolling upland, mild slopes form 6500- to 7500-feet elevation. Faults running perpendicular to the topographic axis have created escarpments and basins. Drainage in this part of the range is primarily southeast-northwest and are related to the faulted structure of the bedrock. The southwest end of the range is marked by some irregular hills reaching 8500-feet elevation.

The Tobacco Root Mountains form a roughly elliptical mass with the long axis trending NNW-SSE. High glaciated terrain consisting of peaks and ridges extends most of the length of the range. Several peaks are well in excess of 10,000-feet elevation. Sharp topographic discontinuity separates the range from the adjacent valleys on several sides, particularly the northwest side.

The Tobacco Root Mountains are separated from a mountain group to the south consisting of the Greenhorn and Gravelly Ranges by a lower area resembling a large saddle. The saddle area is a divide between the Ruby River drainage basin and the Madison drainage. Minimum elevations on the saddle are nearly 7000 feet, as compared to about 5000 feet in the adjacent valleys. The saddle is crossed by a major highway and contains Virginia City.

About eight miles south of Virginia City, Baldy Mountain rises to over 9000 feet. The Gravelly Range forms the Ruby-Madison drainage divide and contains uplands within the study area of about 8000 feet elevation. The Greenhorn Range contains one peak about 9700 feet elevation.

The Madison and Gallatin Ranges form an almost continuous mountain mass from the Madison Valley to the valley of the Yellowstone. Dividing this mountainous area is the Gallatin River and its narrow canyon. Streams in these ranges empty into the Madison, Gallatin, and Yellowstone Rivers. In the northern portion of the Madison Range lies a particularly high mountainous region known as the Spanish Peaks, with peaks over 10,000 feet. The western side of the range is marked by a number of isolated peaks, including Lone Mountain, which is over 11,000 feet in elevation. The center of the Gallatin Range also contains some ridges and peaks over 10,000 feet (see Figure 6-2).



PHYSIOGRAPHY AND CROSS SECTION OF MADISON RANGE IN VICINITY OF BIG SKY PROJECT

Figure 6-2

East of the Yellowstone River and Paradise Valley are more high mountains, only the edges of which lie within the study area. These mountains, the Absaroka Range, are part of the Middle Rocky Mountain province.

North of the Gallatin Range, a narrow zone of rather high mountains, the Bridger Range, forms the eastern edge of the Northern Rocky Mountain Province. These mountains rise abruptly from the Gallatin Valley (at about 5000 feet elevation) to elevations over 9000 feet. These mountains are drained by tributaries of the Gallatin River and the Shields River. East of the Bridgers, the topography is developed by differential erosion upon sedimentary rocks (Livingston Formation) and variously-sized igneous bodies. The Shields River valley is not of the type of broad valleys found west of the Bridgers. Likewise, the Crazy Mountains, just outside of the northeast corner of the study area, are the result of differential erosion, and not block faulting.

II.B. Slope

One of the determinants of environmental impact is the slope of the surface that a given activity is performed upon. For instance, in the case of transmission lines, the slope determines the amount of road-building necessary to construct the line (except where helicopters are used). The stability of a slope and erosion potential are in part determined by the degree of slope.

Uniform topographic coverage of the study area exists at a scale of 1:250,000 on the two-degree topographic map series (sometimes referred to as the AMS series). The Department of Natural Resources contracted with the U.S. Geological Survey Topographic Division to produce slope maps from the existing Bozeman and Dillon two-degree maps. The technique used is an optical-mechanical system which can be used on the plates of a published topographic map. A number of slope maps produced by this method at various scales have been published.

Six slope zones as shown below were selected (see slope map contained in the pocket on the back cover);

1. 0-5%
2. 5%-10%
3. 10%-30%
4. 30%-45%
5. 45%-60%
6. > 60%

Those areas having a slope greater than 60% (31^0) are steeper than the angle of repose for most earth materials.

Because the photo mechanical process which produces the map uses the distance between contour lines to arrive at a slope value, artifacts are sometimes generated. False slope values occur where the same contour recurves and lies near itself. The process cannot distinguish the proximity of the same contour from adjacent contours. This artifact is especially well developed on the gentle slopes northeast of Dillon. Shallow stream channels eroded into the smooth low angle surface cause the contours to be sinous, which, in turn, result in apparent slopes of greater than 45% which do not in fact exist there. However, other areas having the appearance of artifacts (generally flatter areas) are often real features.

The slope maps are perhaps most useful in the mountainous areas. Potential corridors following valleys are easily observed if a mountainous area must be traversed. The detail and quantitative slope values on the slope maps are impossible to obtain by conventional use of aerial photographs within reasonable amounts of time.

II.C. Stratigraphy

The study area contains igneous, metamorphic, and sedimentary rocks ranging in age from Precambrian to Recent. All or nearly all major rock types are represented. Within this area, many rock units have been identified and mapped. The requirements of transmission line siting differ from those of deciphering geologic history or structure (although knowledge of the history and structure are used). It makes little difference to the building and operation of a transmission line whether the bedrock contains trilobite eyes or mouse teeth if the engineering properties of the rock are the same.

The only geologic map that treats the entire study area is the Geologic Map of Montana (Ross, Andrens, and Witkind 1955), from which the map entitled "Generalized Bedrock Geology" in this section was made. The complex stratigraphy in this area was generalized into the following seven units (recognizing the diversity of rock types in each unit):

Volcanic rocks
Intrusive igneous rocks
Livingston Formation (northeastern portion only)
Cenozoic sedimentary rocks
Mesozoic sedimentary rocks
Paleozoic sedimentary rocks
Precambrian rocks

These particular divisions were established for two reasons:

1. The divisions allow larger, continuous mapping units
2. Engineering properties of the rocks are divisible along the same boundaries, in a general way.

The mapping units could have been established on other criteria, such as rock type, strength, or degree of fracturing. However, it would have been impossible within the time and resource constraints to remap an area of this size to obtain the information necessary to make such a map. Table 6-1 compares the seven units in terms of some properties relevant to the construction and operation of transmission lines. These comparisons indicate the general way a rock responds. As pointed out earlier, the engineering

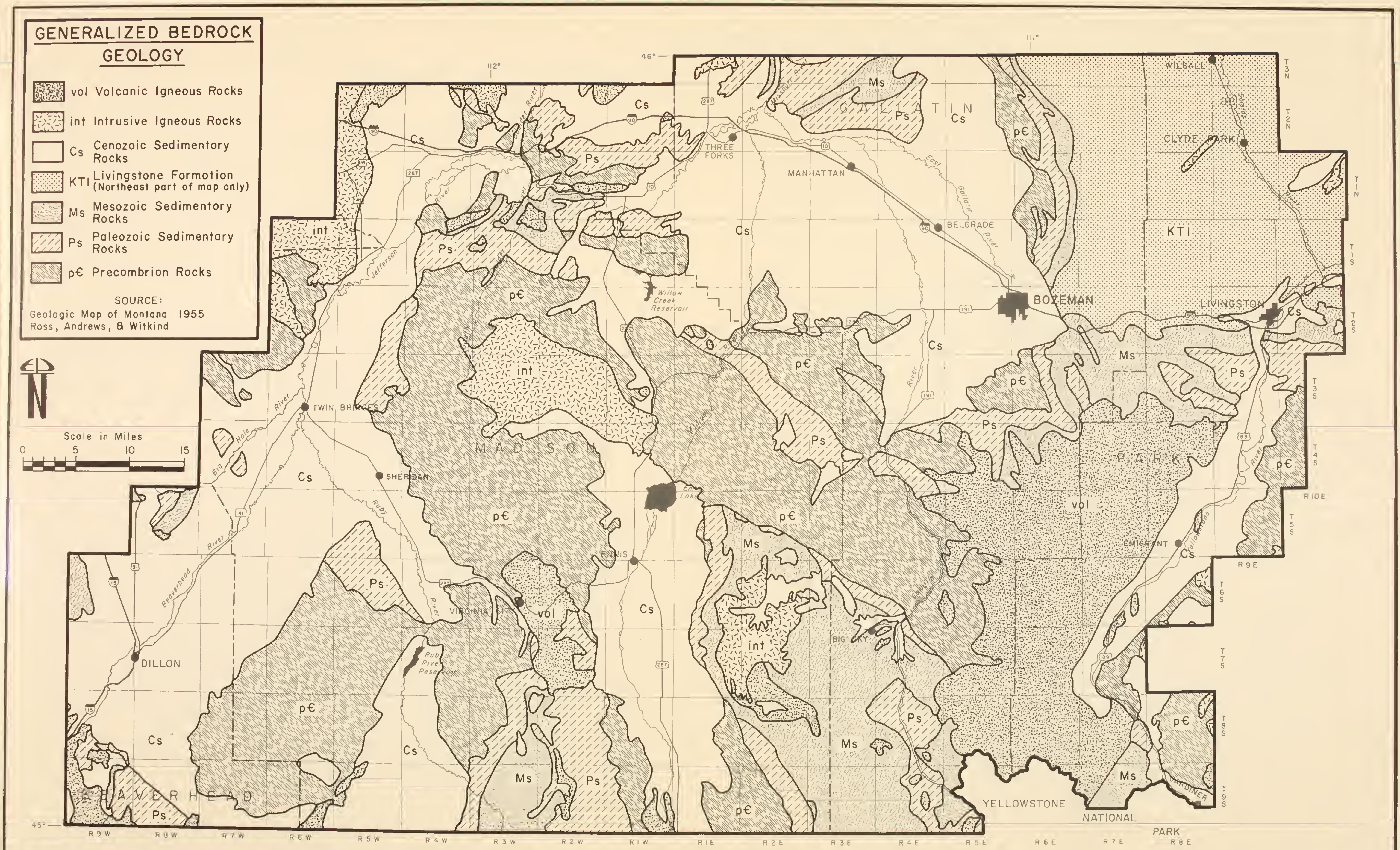


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TABLE 6-1

PROPERTIES AND CHARACTERISTICS OF GEOLOGY MAP UNITS

Map Symbol	p€	Ps	Ms	KTl	Cs	INT	VOL
Bearing Strength or Solidity of Fresh Rock	Good	Good	Good to Poor	Fair	Fair to Poor	Good	Fair to Good
Ease of Excavation	Difficult	Moderate to Difficult	Moderate to Easy	Moderate	Moderate to Easy	Difficult	Moderate to Difficult
Slope Stability	Good	Fair to Good	Fair to Bad	Fair	Fair to Poor	Good to Poor	Fair to Poor
Topographic Form (Height Development)	Medium to High	Medium to High	Medium to High	Medium to Low	Low	Medium to High	Medium to High
Structural Characteristics	Strongly Folded and Faulted	Strongly Folded and Faulted	Moderately to Strongly Deformed	Moderately Folded	Mostly Undeformed	-	Moderately Deformed

NOTE: Because each property is dependent upon a number of local conditions and each unit consists of a number of lithologies, the ratings shown in this table are highly generalized.

properties of rock depend upon many local conditions, such as degree of fracturing, attitude of fracture and bedding planes, groundwater conditions, and slope. A rock unit which is typically strong and capable of supporting steep slopes may in a few places be extremely weak and unstable. A description of each of the seven stratigraphy units follows (Figure 6-3).

II.C.1. Precambrian Rocks

The Precambrian rocks of the study area are composed of two groups: (1) a complex of high-grade metamorphic rocks, and (2) the Belt series.

The metamorphic terrane consists of gneiss, schist, marble (some dolomitic), amphibolites, metaquartzites and other crystalline rocks. The complex has been divided into several formations, but correlation and age relationships of what has been assigned each formation is uncertain. The Cherry Creek and Pony formations are metamorphosed sediments. The Dillon Granite Gneiss, youngest of the Pre-Belt rocks, has been traditionally regarded as metamorphosed granite; however, there is some doubt that this view is correct. Radiometric dating indicates ages of these rocks to be from 1600 to 3200 million years (Giletti 1966). Periods of deformation and metamorphism have produced complex structures so that bedding and foliation are at all altitudes.

The Belt series are sedimentary rocks deposited upon the metamorphic basement. In the study area, the Belt series is limited to three minor areas along the northern edge: 1) the Jefferson Canyon area, 2) the Trident area, and 3) the Bridger Range.

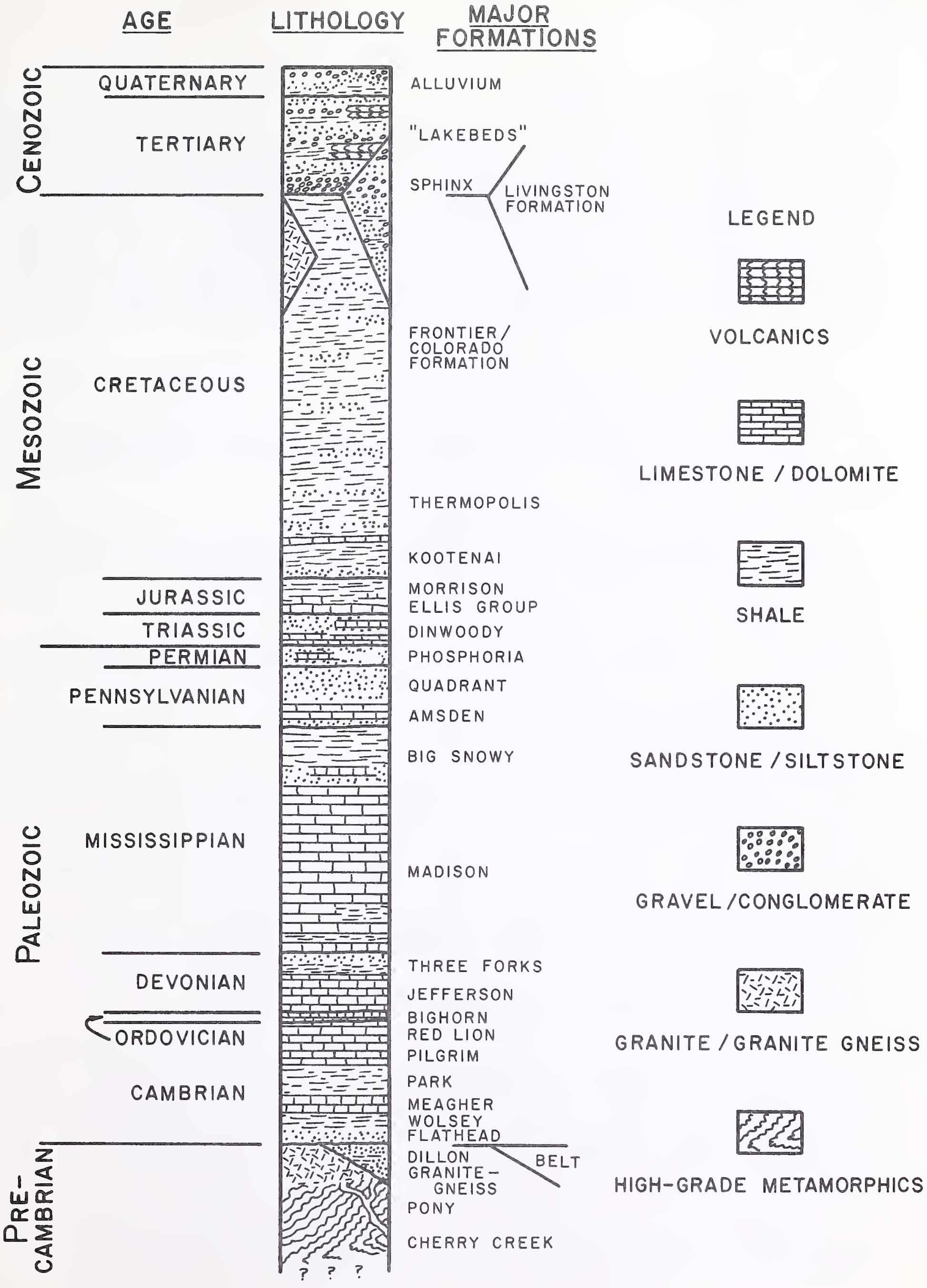
II.C.2. Paleozoic Sedimentary Rocks

The Paleozoic era is represented in the study area by a number of formations ranging in age from Cambrian to Permian. No Silurian and almost no Ordovician strata are present. All types of sedimentary rocks are present in these formations. Figure 6-3 is partly derived from Hadley's (1960) study in the Gravelly Range and generally describes the Paleozoic stratigraphy.

Paleozoic rocks are found throughout the study area in all the major ranges and contribute greatly to the physiographic and scenic character of the mountains.

II.C.3. Mesozoic Sedimentary Rocks

The study area contains small amounts of Triassic and Jurassic strata and thick Cretaceous deposits. The Mesozoic rocks are of particular importance, especially in the central part of the Madison Range, because they form unstable slopes. Some of the Mesozoic terrane consists almost entirely of landslide debris. The lithology and formations of the Mesozoic rocks are shown on Figure 6-3.



GENERALIZED STRATIGRAPHIC COLUMN
(ONLY PARTIALLY TO SCALE)

Figure 6-3

II.C.4. Livingston Formation

The Livingston Formation covers an area north of the Yellowstone River and east of the Bridger Range. Its age is late Cretaceous to early Tertiary, and is thickest (about 14,000 feet) just east of the Bridger Range. McMannis (1957) divided this formation into five units: 1) the lowest unit consists of 4500 feet of shale, sandstone, conglomerate, and some nodular limestone, 2) 3500 feet of sandstone, shale, and bentonitic clay, 3) 3500 feet of sandstone and conglomerate which is more resistant than the other units, and supports Battle Ridge, northwest of Clyde Park, 4) 2000 feet of sandstone and some conglomerate, and 5) 1000 feet of conglomerate.

II.C.5. Cenozoic Sedimentary Rocks

The Cenozoic sedimentary rocks can be discussed in four categories: 1) the Sphinx conglomerate, 2) the "lakebeds," 3) glacial deposits, and 4) Quaternary alluvium.

The Sphinx conglomerate is early Tertiary in age, probably Paleocene or Eocene. This formation is a red, coarse conglomerate which is restricted to Sphinx Mountain and an adjacent peak known as the Helmet. Both of these peaks lie near the front (western edge) of the Madison Range, about eight miles south of Lone Mountain. Although geologically interesting, this formation is of little importance to the proposed transmission line (because of its limited distribution and its occurrence on a steep-sided mountain).

The term "lakebeds" is an unofficial one which applies to a number of formations comprising Tertiary terrestrial and fresh water deposits occupying the valleys and basins in western Montana. These rocks range in age from about late Eocene to Pliocene. The lithology includes sandstone, siltstone, shale and mudstone, conglomerate, limestone, carbonaceous deposits, and much volcanic ash and debris. In some basins, the volcanic material comprises half of the rock. Thicknesses of these deposits range from a few feet to thousands of feet. The fossil content varies in amount and species content. The commonality of the "lakebeds" is that they are terrestrial and/or deposited in fresh water (streams, swamps, lakes) and are composed of the erosion products of nearby uplands and volcanic debris. For the greater part, these beds have not been incorporated in any intense deformation, and occur in the extant basins and valleys of the study area.

Glacial deposits in the mountains are not shown on the bedrock geology map, but occur throughout the higher portions of the study area and in many of the mountain valleys. Some till and outwash occur in the major valleys where some of the valleys exit the mountain. The Yellowstone Valley contains extensive glacial deposits (till and outwash). Till, especially on steep slopes, forms unstable slopes when the material becomes wet.

Quaternary alluvium consisting of unconsolidated gravel, sand, and silt is found in all major stream bottoms. The behavior of this material is dependent upon its relation to the stream and its coarseness.

II.C.6. Intrusive Igneous Rocks

Small dikes and sills occur throughout much of the study area, but are not large enough to appear on the geologic map. Important areas are the Boulder Batholith (northwest corner of the study area), the Tobacco Root intrusives, the intrusion in the Madison Range (around Lone Mountain), the small intrusions near Clyde Park, and those east of Paradise Valley. The first and last of these will not be discussed further since they are so peripheral to the area. The Tobacco Root intrusion is the same age as the Boulder Batholith (Giletti 1966), and consists of mostly quartz monzonite with some diorite, gabbro, and other plutonic rocks.

The Lone Mountain intrusion is a system of sills which radiates from a central core. Swanson (1950) indicates a system of several centers with the sills radiating as limbs on a Christmas tree. These rocks are andesite porphyries, and form unstable slopes on which landsliding is common when intruded into Mesozoic sedimentary rocks.

Near Clyde Park are a number of exposed lacoliths and dikes which are part of the Crazy Mountain intrusives (mostly outside of the study area). One intrusive body shown on the bedrock geology map forms a moderately high ridge.

II.C.7. Volcanic Igneous Rocks

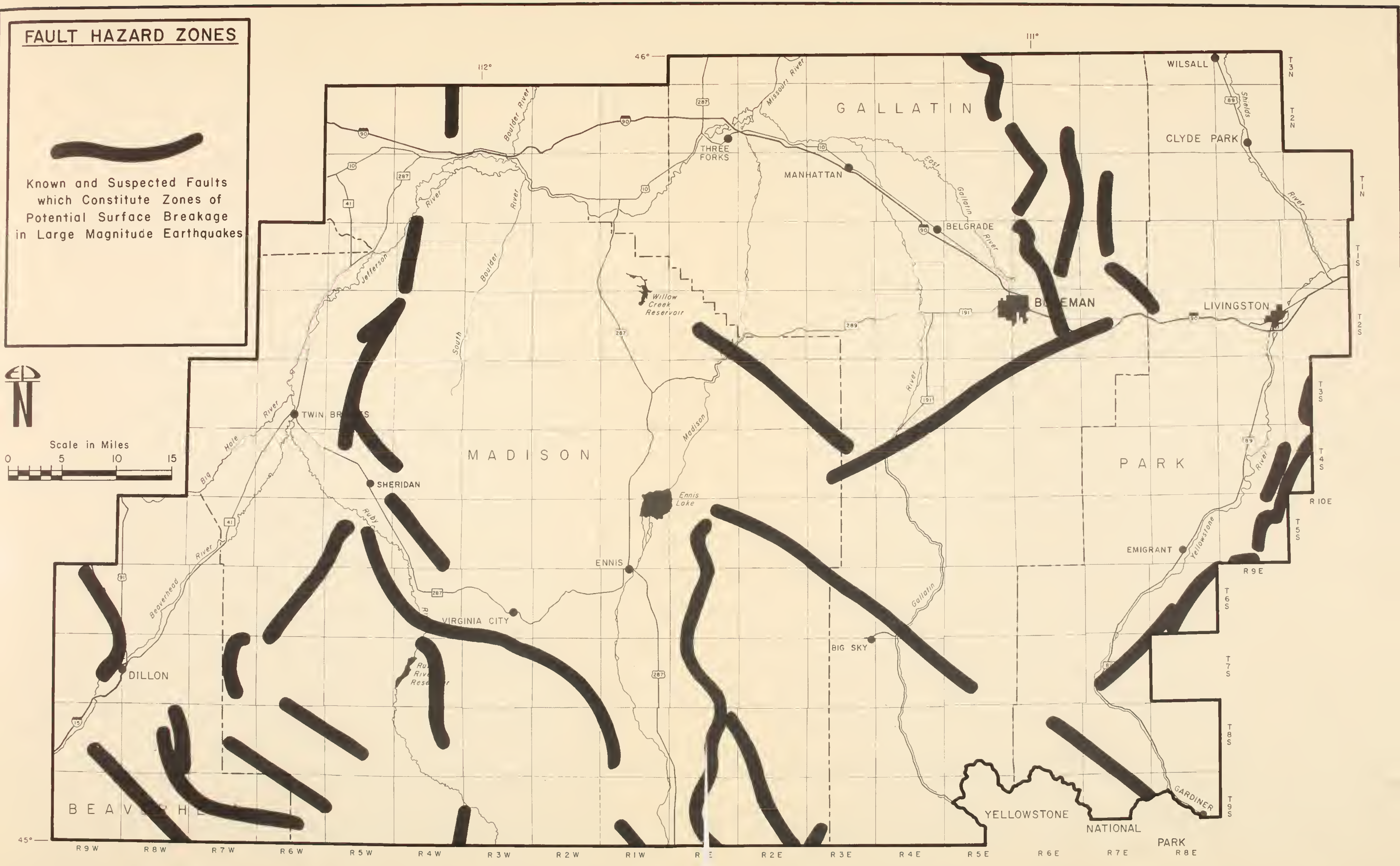
Volcanic rocks are distributed over much of the area. Except for an area near Virginia City and another in the Gallatin Range, these rocks generally occur in small isolated remnants. The rocks are rhyolitic and andesitic flows and welded tuff with some basalt flows ranging in age from Eocene to Pleistocene (mostly Eocene-Oligocene and Pliocene-Pleistocene).

II.D. Seismicity

The study area lies in one of the most seismicly active areas in the conterminous United States. The intermountain seismic belt, a poorly defined zone of epicenters running from northwestern Montana through southern Utah, passes through the study area. The largest earthquake ever recorded in this zone was the Hebgen Lake event in August 1959, which occurred just south of the study area. Damaging or potentially damaging quakes have occurred nearby in 1925 (near Trident), 1935 (Helena), and 1947 (southern Madison County) (Coffman and vonHake 1973). Numerous fault scarps (see map entitled "Fault Hazard Zones"), some quite fresh-looking, occur within the study area. It has been suggested that within the past few centuries an extremely large earthquake may have occurred which involved simultaneous movement along faults near Lima, Montana, the northern edge of the Centennial Range, and along the western edge of the Madison Range (Pardee 1950). If these various "fresh" scarps were not created in one extremely large earthquake, they must have been made by numerous smaller events in the magnitude of the Hebgen Lake shock. It is likely that damaging earthquakes will continue to occur in southwestern Montana and within the study area during the life of the proposed transmission line. Therefore, some consideration of the hazard should be taken into account in the planning of the line.

Earthquakes occur when rapid movement takes place along a fault. The portion of the fault which moves may be near the surface or many miles deep. The August 1959 event is the only Montana earthquake in recorded history to involve ground breakage along the fault trace. All other historic Montana earthquakes, including those in 1935 which caused so much damage in Helena, have not been associated with surface faulting. However, the existence of numerous fresh-looking fault scarps (the growth ring dating on a tree growing on one such scarp indicates the scarp must have been formed prior to 1755) suggests that delineation of active faults is a worthy pursuit.

Defining what·constitutes an active fault (much less identifying them in the field) is problematical. Extremely active ones, such as the San Andreas in California, are not difficult to identify. Likewise, the Madison fault along the western edge of the Madison Range presents no problem in identification as active, but does generate questions as to its implications in near-future (within a century of two) earthquakes. There are also numerous faults in the mountains that are not active because the forces which orginally caused them no longer exist (faults involved in earlier mountain-building phases which are now exposed at the surface and are almost certainly incapable of renewed movement). Finally, there are numerous faults which have not moved in thousands - perhaps tens-of-thousands - of years, but cannot be discounted as being active and capable of producing a large earthquake at any time. From calculations based upon rates of uplift along faults in western Montana, tens-of-thousands of years may exist between movements. Scarps from previous movements may be destroyed by erosion or sedimentation (particularly alluvial fan and glacial deposits), and the fault itself may not be recognized, or its size misunderstood. Recent advances in earthquake prediction and speculation on seismic behavior is of little help in western Montana. Zones of moderate seismic activity within the intermountain seismic belt (numerous small earthquakes) are interpreted by some as high-risk areas and by others as places where a build-up of strain is not occurring; thus, of little danger from damaging tremors. A similar controversy exists in regard to the immediate hazard along an active fault that has recently had a large earthquake. The lack of knowledge of the temporal distribution of activity along faults prevents clarification of this point. If a given fault moves only once every 20,000 years or so, each time releasing nearly all of its potential energy, a recently activated one such as the Madison Fault would be the safest place to build. However, if the movement along a fault is episodic and occurs in a series of closely timed events (decades or centuries separating individual events and hundreds-of-thousands of years separating the episodes), the Madison Fault is not the place to build. Equally convincing arguments can be made by the proponents of either side. As a result of these uncertainties, it is not possible to accurately classify (on the basis of seismic risk) those faults which are believed to be active. The fault hazard zone map shows the location of known and suspected faults, along which surface breakage may occur, but does not indicate relative risk.



CLYDE PARK—DILLON 161 KV TRANSMISSION LINE PROJECT **ENERGY PLANNING DIVISION, DNR & C 1976**

III. General Impacts and Constraints

Geologic patterns affect the cost of construction and maintenance of transmission lines as well as the reliability of the system. However, least cost and maximum reliability are not the only factors that should be considered. A long list of potentially relevant geologic factors could be generated. However, a particular transmission line in a particular region may not be affected significantly by all the geologic factors on the list. Many of the potentially listed factors would require special knowledge that is either unobtainable or obtainable at a cost exceeding its value. Following is an abbreviated list of relevant geologic factors for the proposed Clyde Park-Dillon transmission line:

1. Physiographic constraints
2. Slope stability
3. Foundation problems
4. Hydrologic problems
5. Erosion hazards
6. Seismicity

Each of the topics listed above will be discussed separately in this section, except erosion hazards, which will be covered in section 6.3.2.3. (Soil) in more detail.

III.A. Physiographic Constraints

In areas containing diverse geomorphic forms, such as extensive bodies of water, coastlines, or considerable topographic relief, man's settlement patterns and engineering works are constrained by the physiography. Although it may be possible to cross a mountain, lake, or swamp with a transmission line, the costs in doing so often outweigh the selection of another route. Even if a straight line between terminal points on a transmission line passes over a high peak, the line is more likely to be routed around the peak through a valley or notch if the range itself cannot be avoided.

The Clyde Park-Dillon study area contains nearly flat valleys, hills, and high mountains. Slopes range from imperceptible to vertical. The difficulty and cost of building in a given location is weighed against the need for the location and the alternatives which are available. The need to serve Big Sky and the alternatives which exist in doing so determines whether the Madison Range is to be crossed. Similarly, the Ruby Range could be avoided by moving the route from the straight-line course between Clyde Park and Dillon. Since slope is intimately associated with other physiographic limitations in the Clyde Park-Dillon study area, the avoidance of steep slopes will coincide with the avoidance of most other constraints (such as high elevations and rough topography). Use of the slope map alone in corridor selection will give consideration to this geologic factor.

Lakes and wet areas are limited in the study area and do not constitute major constraints.

III.B. Slope Stability

The force of gravity acting on materials lying on a slope tends to reduce the height of the materials. When the downward force of gravity exceeds the internal friction or strength of the material, the slope fails and some form of mass movement occurs. The landslide (the term landslide, as used in this report, is the general term which includes all forms of mass movement except soil creep and rock fall when individual rocks or a small number of rocks are involved) can be one of a variety of kinds, can occur very slowly or quite rapidly on surfaces ranging from steep to those with only one or two degress of slope.

Landslides range in size from a few feet to thousands of feet. In some cases only surface material is involved, and in other cases solid bedrock fails. Landsliding is a common geologic phenomenon and can be seen in many places in the Rocky Mountains, but generally goes unnoticed until roads fail or when the neighbor's house suddenly appears on the back patio.

In many areas, landsliding is a dominant geomorphic process. Certain terrane is almost continuous landslide debris, whereas in other terrane, landsliding occurs only where a number of favorable factors occur together. Some areas are devoid of any landsliding.

Conditions which influence the development of landsliding include:

1. Steepness of slope
2. Character of bedrock
3. Degree and depth of weathering
4. Character and degree of fracturing
5. Character of bedding in sedimentary rocks
6. Attitude of bedding and fracture planes
7. Hydrologic system involved (amount of water present)
8. Earthquakes
9. Undercutting of slope by erosion or man
10. Overloading of top of slope

The importance of slope stability to transmission lines is obvious. Disturbing steep slopes by access roads, timber cutting, and the alteration of water uptake and run-off can initiate a sequence which ends in some slope failure. The induced landslides can occur immediately or many years later. Naturally occurring landslides on inherently unstable slopes also pose a threat to the reliability of a transmission line. Landslides can increase the cost of construction and result in greater erosion, leading to increased siltation of surface waters.

Only three of the above conditions were analyzed for slope stability evaluation in the study area - slope, character of the bedrock, and moisture (total precipitation). Earthquake hazard (from ground motion only) was considered to be uniform over the entire area for purposes of slope stability evaluation.

III.C. Foundation Problems

Wooden utility poles do not need a strong foundation compared to many other engineering works; however, especially weak ground or ground subject to subsidence, or shrink-swell conditions can pose problems. Other than on unstable slopes and flood plains, there are few places within the study area where foundation problems may exist.

III.D. Hydrologic Problems

Water can change some of the properties of rocks. In a slope, it adds to the weight and reduces the strength of the material. For this reason, landslides often occur after heavy rains or in wetter-than-normal years. The diversion or alteration of hydrologic systems can induce slope failure or produce wet ground where none previously existed. North-facing slopes behave differently than south-facing slopes, partly because of the moisture differences. Slopes which receive moisture from beneath, especially where it may be concentrated in low places, or come to the surface at the bases of cliffs (or cut banks of roads), may behave quite differently than slopes underlain by the same rock unit but which are not so wet.

Another hydrologic problem arises from flooding. Transmission line structures may not be as susceptible to flooding damage as some other works, but flood plains should be avoided where possible.

Construction activities, particularly on steeper slopes, often increase erosion. Erosion hazards are covered in the section on soils in greater detail, but local hydrologic conditions can intensify environmental impacts caused by erodible materials.

III.E. Seismicity

For earthquake-resistant structures, such as wooden transmission towers, the greater danger in an earthquake comes from secondary events. Landsliding, rockfall, and flooding constitute considerable hazards in even moderate earthquakes, or larger but distant ones. The nature of these hazards is produced by local conditions and is only initiated by the shock. The risk of large earthquakes occurring in or adjacent to the study area lends more importance to the consideration of usual geologic hazards (such as slope stability and rockfall hazards) plus seiche and flooding that would be restricted to earthquake-related phenomena.

6.3.2.3. Soil

I. Introduction

The inventory contained in this section has been represented in a different manner than in other sections of this publication. The inventory consists of a soil association map (contained in the pocket in the inside back cover) and a 49-page descriptive legend (Table 6-2). The following information is found in the descriptive legend: geomorphic surfaces, possible included soil series, subgroups, families, soil depths, slope ranges, and descriptive notes. Table 6-2 is followed by a brief description of the general impacts upon soil to be expected from the construction of a transmission line.

The soils inventory was designed to assess the concerns of road construction suitability and erosion hazard (see Figures A and B). To evaluate these concerns, the soils map was made at the association level. A soil association is the combination of soils that occurs on a specific geomorphic surface with specific climate, vegetation cover, elevation, slope, and soil characteristics within predetermined ranges. These associations are expressed on the map and in Table 6-2 as mapping units. Mapping units often appear similar to each other, but are differentiated by additional data found in the descriptive notes of the legend.

To arrive at the specified mapping units geomorphic delineations were produced on overlay sheets from aerial photographs (scale 1:63,000) using stereoscopes. These initial units were checked in the field for accuracy of line placement and for soils content. Thus the legend content was supplied by field checking and research. Where Soil Conservation Service mapping existed, it was absorbed by this mapping effort.

To categorize the kinds of soil found, the soil taxonomy developed by the National Cooperative Soil Survey of the USDA was used. This classification scheme is known as the Seventh Approximation and classifies the soils by their individual characteristics. The taxonomic units used in Table 6-2 are the subgroup, family, and series, each of which indicates particular soil characteristics.

The subgroup name provides data about the soil moisture regime, soil temperature regime, and the diagnostic horizons. A diagnostic horizon has specialized characteristics and typifies the soil in which it is found, taxonomically separating that soil from all other soils not having the same type of diagnostic horizon. Any soil may have several horizons (distinct layers roughly parallel to the surface and separable from other layers), but will have only one or two horizons considered as diagnostic by the taxonomy. The family indicates particle-size class, minerology class, and reaction class (among others less important here). Particle-size class refers to the grain size distribution for the whole soil, mineralogy class refers to the mineralogical composition, and reaction class refers to pH level and the presence or absence of carbonates.

The series, however, is the basic unit and carries with it a soil description which contains differentiae not inferred by either the subgroup or family. The description includes the separation of the horizons; the structure (manner of particle aggregation); the color and texture or percentage of sand, silt, and clay of each horizon; the dominant vegetation; the geographic setting, the range in characteristics, and the location of establishment from which the series gets its proper name. It is primarily from soil series descriptions and their accompanying interpretive charts and Table 6-2 that this inventory makes its interpretations. One subgroup and family will often have several series names associated with it.

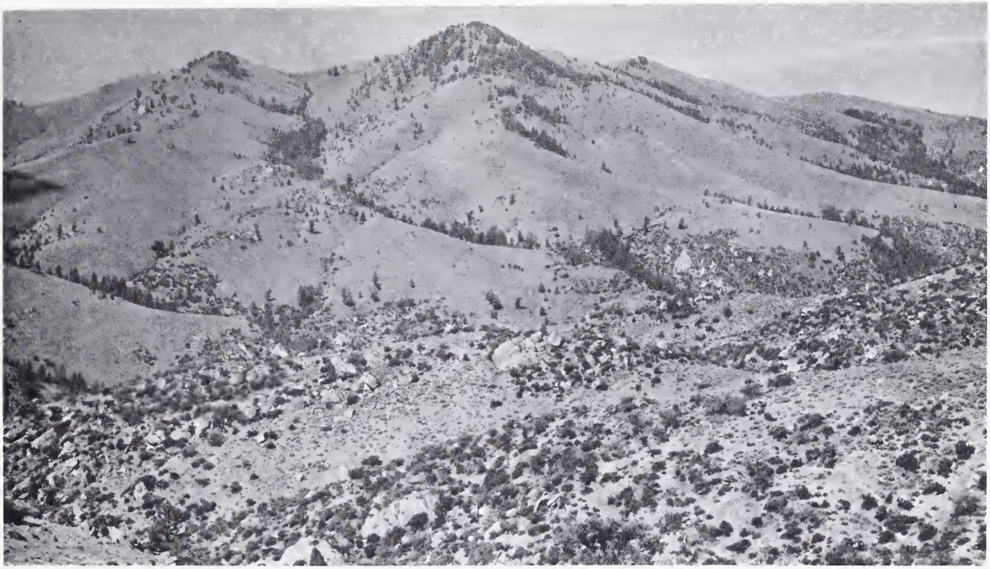


Figure 6-4. In the foreground are bouldary phases of shallow soils; the area has poor road suitability and moderate erosion hazard. The background has moderately deep soils on most slopes, and deeper soils in the swails and on gentler slopes, but is very poor for roads and very high in erosion hazard.

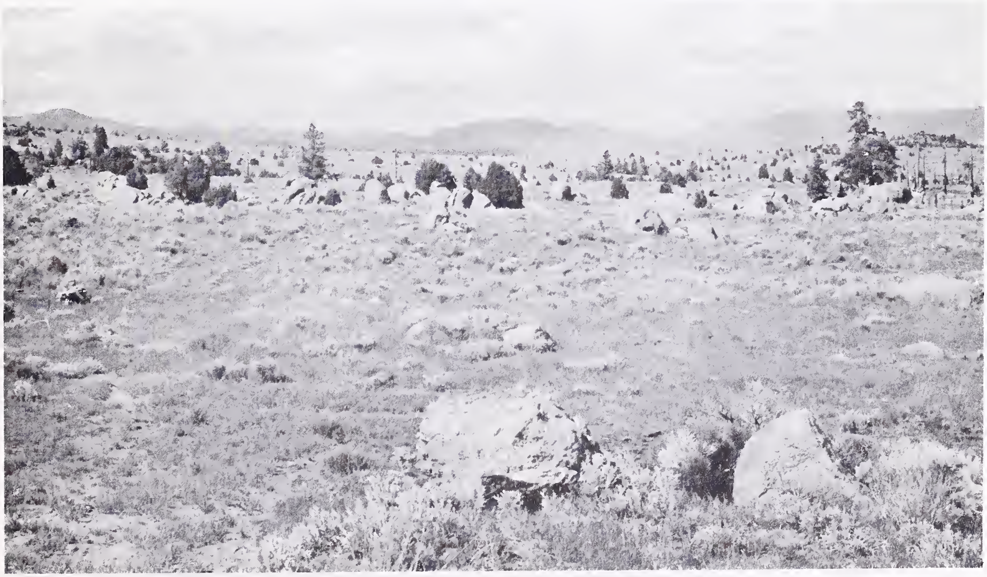


Figure 6-5. This area has bouldary phases of deep and moderately deep soils. There is little agricultural potential, but some wind erosion hazard; no objections to transmission line construction.

II. Inventory/Table 6-2

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
1.	undulating and hilly portions of the foothill region near the Bridger Mts.	Loberg Granile (Colo)	Typic Cryoboralfs Typic Cryoboralfs	clayey-skeletal, mixed loamy-skeletal, mixed	>40" >40"	U	fir, spruce and Ponderosa pine - excellent timber production established along Olsen Creek road; limited to non-calcareous parent rocks.	5-25%
2.	steep and very steep valley side walls which have been dissected into the flatter upland topography	Lake Creek (Wyo) (mineralogy variant) Gambler Devore (Wash) Garlet	Typic Cryoboralfs Typic Cryoboralfs Typic Cryochrepts Typic Cryochrepts	loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed	20-40" >40" 20-40" >40"	A	moderately productive timber stands on the northern slopes dominated by spruce and fir with some inclusion of a grass and shrub parkland type; unit confined to the non-calcareous Boulder batholith and pre-belt rock types; Lake Creek and Gambler soils are found in areas where there is accumulation of additional moisture and downslope movement of fine materials. Rock outcrop, scree and talus of 10-35%.	45-60+%
3.	moderately steep to steep mountainous uplands	Loberg Garlet	Typic Cryoboralfs Typic Cryochrepts	clayey-skeletal, mixed loamy-skeletal, mixed	>40" >40"	A	kettle and kame topography of till deposits located midway between the steep bedrock dominated uplands and the grassland soils developed in till of lower elevations and/or valley floors; rock outcrop occurs as narrow ridges or knobs; primarily Douglas fir and Lodgepole pine plant communities.[1]	8-40%
4.	undulating and hilly glaciated high mountain valleys	Sicklesteets Loberg Blackleed Granile (Colo)	Typic Cryoboralfs Typic Cryoboralfs Typic Cryochrepts Typic Cryofibrists Typic Cryoboralfs Typic Cryoborolls	fine, mixed clayey-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed clayey-skeletal, mixed	>40" >40" >40" >40" >40" 20-40"		fir, spruce and whitebark pine forests, developing on non-crystalline igneous rocks and pre-belt gneiss and schist; Cryofibrists in areas of moisture accumulation and concentration, related to Unit #23 which has the Spodosol (Tenex series) component.	8-30%

* Refers to undifferentiated units (U) or soil associations (A).

[1] Mapping and unit definition largely adapted from Olsen, J.A., Leeson, BLFL, and Nielsen, G.A., General Soils Map - Soil Interpretations for Land Use Planning and Development in the Gallatin Canyon Area, Montana, Montana Agricultural Experiment Station, Montana State University, Misc. Report No. 10 (1971).

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
5.	moderately steep mountainous, high elevation uplands	Gambler (calcareous variant)	Typic Cryoboralfs	loamy-skeletal, mixed	>40"	A	Cryoboralfs, Cryocrepts and Cryorthents occur on the north- and east-facing slopes; forest cover of Douglas fir, spruce, and whitebark pines; most of the soils differ from modal in having calcareous materials in their regoliths, rock outcrops of various lithologies ranging from gneiss and schist to linestone, shale and sandstone which comprise 15 to 45 percent of unit. Rock outcrop of 15-45%.	15-45%
		Garlet (calcareous variant)	Typic Cryochrepts	loamy-sekeltal, mixed	>40"			
		Lake Creek (Wyo)	Typic Cryoboralfs	loamy-skeletal, mixed	20-40"			
		Merino (calcareous variant)	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"			
		Blaine (deep variant)	Argic Cryoborolls	loamy-skeletal, mixed	>40"			
		Blaine	Argic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Bridger	Argic Cryoborolls	fine, mixed	>40"			
		Nielsen (Ida)	Argic Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
7.	moderately steep and steep mountain slopes along the east flank of the Bridger mountains	Lick	Typic Cryoboralfs	fine-loamy, mixed	>40"			30-60%
		(t) Sangrey	Argic Pachic Cryoborolls	fine-loamy, mixed	>40"			
		(t) Oro Fino	Argic Cryoborolls	fine-loamy, mixed	>40"			
8.	steep, high elevation mountainous uplands	Woodrock (Wyo)	Typic Cryoboralfs	fine-loamy, mixed	20-40"	A	Hazton has been correlated out to Cheadle (Lithic Cryoborolls, loamy-skeletal, mixed) by the SCS office in Bozeman; parent rock is of a noncalcareous igneous type.	20-60%
		Lucky (Colo)	Argic Cryoborolls	fine-loamy, mixed	20-40"			
		Hazton (Wyo)	Lithic Cryoborolls	loamy, mixed	<20"			
			Lithic Cryoborolls	sandy-skeletal, mixed	<20"			
		Carbol (Colo)	Argic Lithic Cryoborolls	loamy, mixed	<20"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
9.	moderately steep and steep mountainous uplands	Gambler (moderately deep variant)	Typic Cryoboralfs	loamy-skeletal, mixed	20-40"		confined to the Boulder batholith and pre-belt rocks which lack carborates; area in South Meadow Creek has little of the 20 to 40" component.	20-50%
		Gambler	Typic Cryoboralfs	loamy-skeletal, mixed	>40"			
		Lolon	Pachic Cryoborolls	loamy-skeletal, mixed	>40"			
		Woodhurst	Argic Pachic Cryoborolls	loamy-skeletal, mixed	>40"			
		Garlet	Typic Cryochrepts	loamy-skeletal, mixed	>40"			
10.	glaciated high mountain uplands	Sherlock	Andeptic Cryoboralfs	loamy-skeletal, mixed	>40"		tertiary volcanics dominate bedrock system with the presence of volcanic glass being widespread in the soils; Douglas fir and spruce vegetational dominants.	15-30%
		(t) Tenibac	Andeptic Cryoboralfs	fine-mixed	>40"			
		Coerock	Lithic Cryandepts	medial	<20"			
		Truefissure	Entic Cryandepts	medial over loamy-skeletal, mixed	>40"			
		Garlet	Typic Cryochrepts	loamy-skeletal, mixed	>40"			
		Merino	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"			
		Evaro	Typic Cryorthods	loamy-skeletal, mixed	>40"			
			Typic Cryorthods	sandy-skeletal, mixed				
11.	glaciated and residual tertiary volcanic rocks on high elevation mountain plateaus		Andeptic Cryoboralfs	fine-loamy, mixed	>40"		Douglas fir and spruce vegetative dominants, inclusion of wet meadow types.	4-20%
		Sherlock	Andeptic Cryoboralfs	loamy-skeletal, mixed	>40"			
		True fissure	Entic Cryandepts	medial over loamy-skeletal, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
14.	moderately steep land at high elevation	Blackleed	Typic Cryochrepts	loamy-skeletal, mixed	20-40"		this unit is partially timbered.	20-45%
			Typic Cryorthents	loamy-skeletal, mixed	20-40"			
17.	high elevation marainal deposits in mountain uplands		Typic Cryaquepts	loamy-skeletal, mixed	>40"		established in Gravelly Mts.; aspen and Douglas fir communities dominant; glacial	10-35%
		Sebud	Typic Cryoborolls	loamy-skeletal, mixed	>40"			
		Wishard	Aquic Cryoborolls	loamy-skeletal, mixed	>40"			
			Typic Cryaquolls	loamy-skeletal, mixed	>40"			
			Cumulic Cryaquolls	loamy-skeletal, mixed	>40"			
18.	north and east facing steep mountain slopes	Whitore	Typic Cryochrepts	loamy-skeletal, carbonatic	>40"		sedimentary parent rocks in the Gravelly Mts.; Douglas fir, spruce and Limber pine; Whitore confined largely to small areas where accumulation of downslope sediments has occurred.	20-50%
		Tropal	Lithic Cryochrepts	loamy-skeletal, carbonatic	<20"			
		Whitore (moderately deep variant)	Typic Cryochrepts	loamy-skeletal, carbonatic	20-40"			
19.	steep mountain slopes	Whitore	Typic Cryochrepts	loamy-skeletal, carbonatic	>40"		first segment of unit found on the east and north-facing slopes and second portion on the west and south slopes; unit developed in the Ruby Mts.; rock outcrop is of limestone and limy sandstones. Rock outcrop of 10-20%.	40+%
		Tropal	Lithic Cryochrepts	loamy-skeletal, carbonatic	<20"			
		Garlet (calcareous variant)	Typic Cryochrepts	loamy-skeletal, mixed	>40"			
		Whitore (moderately deep variant)	Typic Cryochrepts	loamy-skeletal, carbonatic	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
19. (cont.)		(t) Southace (Wyo) (moderately deep variant)	Ustic Torriorthents	loamy-skeletal, mixed (calcareous), frigid	20-40"		Rock outcrop of 20-50%.	
		(t) Pensore	Lithic Ustic Torriorthents	loamy-skeletal, carbonatic, frigid	<20"			
		Rentsac	Lithic Ustic Torriorthents	loamy-skeletal, mixed (calcareous), frigid	<20"			
20.	steep and very steep mountain slopes often including strike ridges	Blackleed	Typic Cryochrepts	loamy-skeletal, mixed	20-40"		mixed lithology analog of Unit #9; productive timber unit dominated by Douglas fir; soils contain large quantities of stones and some boulders. Rock outcrop, scree and talus slopes 10%.	30-60%
		Supervisor (NM)	Typic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Hobacker (Wyo)	Pachic Cryoborolls	loamy-skeletal, mixed	>40"			
		Woodhurst	Argic Pachic Cryoborolls	loamy-skeletal, mixed	20-40"			
21.	steep mountainous slopes as a series of ridges and V-shaped canyons	Garlet	Typic Cryochrepts	loamy-skeletal, mixed	>40" (60%)	A	residual soils from quartzite, argillite and hard sandstone; vegetation is primarily Lodgepole pine and Douglas fir; Garlet Series found on long slopes between ridges and drainageways; moderately deep variant of Garlet is common on upper slopes near the ridges; unit is from Gallatin Canyon survey by Olsen, et al.	15-50%
		Loberg	Typic Cryoboralfs	clayey-skeletal, mixed	>40" (10%)			
		Garlet (moderately deep variant)	Typic Cryochrepts	loamy-skeletal, mixed	20-40% (20%)			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
22.	moderately steep to steep mountain uplands	(t) Rambler (Wyo)	Typic Cryorthents	loamy-skeletal, mixed (acid)	>40" (80%)	A	Rambler occurs as a very cobbly loam and stony loam; Garlet, Loberg and moderately deep variants comprise about 20% of unit; non calcareous parent rocks; unit is from Gallatin Canyon survey by Olsen, et al.	15-60%
		Garlet	Typic Cryochrepts	loamy-skeletal, mixed	>40"			
		Loberg	Typic Cryoboralfs	clayey-skeletal, mixed	>40"			
23.	low gradient valley floors and moderately steep cirque walls just below the most recently occupied basins		Humic Cryaquepts	fine-loamy, mixed (acid)	>40"		frequently associated with Unit #76; complex slopes in valley floor ranging from 10-25% with inclusion of the lower portions of the Cirque walls with slopes ranging to 45%, the latter area has considerable accumulation of fines from alluvial/colluvial downslope movement; many stones, cobbles and boulders are found throughout; Cryohemists and Cryaquepts are found near the drainageways and are associated with the wet meadow and Willow communities; spruce, fir and whitebark pine are the dominants.	10-45%
		Rambler (Wyo)	Typic Cryorthents	loamy-skeletal, mixed (acid)	20-40"			
		Libeg	Argic Cryoborolls	loamy-skeletal, mixed	>40"			
		Gambler	Typic Cryoboralfs	loamy-skeletal, mixed	>40"			
		Terex	Typic Cryorthods	loamy-skeletal, mixed	>40"			
			Typic Cryohemists					
24.	moderately steep rolling mountain uplands of medium and high elevation	Garlet (moderately deep variant)	Typic Cryochrepts	loamy-skeletal, mixed	20-40"		parkland type with timber dominated by Douglas fir and some Lodgepole and Limber pine; gravelly and stony phases of the Cryoborolls are frequently encountered; inclusion of Pachic Cryoborolls; developing on sedimentary rocks in Tobacco Roots.	10-40%
		Garlet	Typic Cryochrepts	loamy-skeletal, mixed	>40"			
		Teton	Typic Cryoborolls	fine-loamy, mixed	20-40"			
		Thayne (Wyo)	Typic Cryoborolls	fine-loamy, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
25.	rolling and moderately steep uplands	Cowood (calcareous variant)	Lithic Cryochrepts	loamy-skeletal, mixed	<20"		limited amount of Cryoboralfs and based on less than adequate data, amount of organic matter accumulation and intensity of expression of soil forming factors is strongly correlated with aspect, developing from sedimentary rocks containing carbonates.	20-45%
		Garlet (calcareous variant)	Typic Cryochrepts	loamy-skeletal, mixed	>40"			
		Garlet (moderately deep variant)	Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
		Gambler (calcareous variant)	Typic Cryoboralfs	loamy-skeletal, mixed	>40"			
A25.	steep and very steep escarpments and deeply incised valleys	Cowood	Lithic Cryochrepts	loamy-skeletal, mixed	<20"		primarily utilized in area west of Paradise Valley where it is an extensive unit; inclusion of moderately deep Typic Cryoboralfs, loamy-skeletal, mixed which is found on shorter broken north-facing slopes; basically a southern exposure unit with poor timber stands without closed canopies. Rock outcrop, scree and talus of 15-40%.	45-60+%
		Merino	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"			
		Garlet (moderately deep variant)	Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
26	moderately steep and steep slopes	(t) Starman (Wyo)	Lithic Cryorthents	loamy-skeletal, mixed (calcareous)	<20"		inclusion of a Boralfic Cryoboroll, loamy-skeletal, mixed; parent rocks of mixed lithology; stony and bouldery phases are dominant; deep and moderately deep soils are limited to slope breaks or other areas of greater accumulation of materials; open timber stand largely of Douglas fir which is limited in its productivity. Rock outcrop of 10-30%	10-45%
		Merino	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"			
		Brickel (Wash)	Typic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Blaine	Argic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Ess (Ariz)	Argic Cryoborolls	loamy-skeletal, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
27.	moderately steep and steep slopes which are heavily dissected	Merino	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"		parent rock dominated by schist, gneiss and monzonite; most of the Cryorthents are less than 10" thick; dominant slopes above 35%; vegetation includes Limber pine and juniper with some grassland and shrub and Douglas fir and Whitebark pine at higher elevations. Rock outcrop of 20-50%.	20-60+%
		(t) Mucet	Lithic Cryoborolls	loamy, mixed	<20"			
		Gilispie	Argic Lithic Cryoborolls	loamy, mixed	<20"			
		Lucky (Colo)	Argic Cryoborolls	fine-loamy, mixed	20-40"			
28.	steeply sloping south facing ridges	Merino	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"		shrub and grassland is the primary plant cover; parent rock is of mixed lithology from sedimentary origin; inclusions of a deeper Argic Cryoboroll and a Pachic Cryoboroll.	40-60+%
		Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
		Nielsen (Ida)	Argic Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
		Blaine	Argic Cryoborolls	loamy-skeletal, mixed	20-40"			
29.	finely dissected foothills	Merino	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"		Rock ourcrop of 10-25%.	15-50%
		Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
		Carbol (Colo)	Argic Lithic Cryoborolls	loamy, mixed	<20"			
		Blaine	Argic Cryoborolls	loamy-skeletal, mixed	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
30.	alpine glacial moraines dominated by many moderately steep but short broken slopes and closed morainal basins	Pishkun Sebud Gateview (Colo)	Typic Cryorthents Typic Cryoborolls Pachic Cryoborolls	loamy-skeletal, mixed (calcareous) loamy-skeletal, mixed loamy-skeletal, mixed	>40" >40" >40"		inclusion of Pachic Cryaquolls	7-40%
31.	steep mountain and valley side slopes frequently transitional to the valley floors	(t) Barrett (Wyo) Pishkun (t) Fossilon (Wyo)	Typic Cryorthents Typic Cryorthents Lithic Cryorthents	loamy-skeletal, mixed (calcareous), shallow loamy-skeletal, mixed (calcareous) loamy-skeletal, carbonatic	<20" 20-40" <20"		established and used primarily in the Gravelly Mts. Rock outcrop of 10-45%.	35-60+%
32.	very steep valley walls with large amounts of talus, scree and rock outcrop	Merino Garlet	Lithic Cryorthents Typic Cryochrepts	loamy-skeletal, mixed (nonacid) loamy-skeletal, mixed	<20" >40"		Garlet series found where slope breaks are present or where accumulation of downslope sediments occurs. Rock outcrop of 20-60%.	50-60+%
33.	rounded mountain crests and tops into which deeply dissected and steep canyons have been cut	Merino Cowood Garlet Gambler	Lithic Cryorthents Lithic Cryochrepts Typic Cryochrepts Typic Cryochrepts Typic Cryoboralfs Typic Cryoboralfs	loamy-skeletal, mixed (nonacid) loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed	<20" <20" 20-40" >40" >40" 20-40"		spruce and fir dominated vegetative cover; parent rock dominated by gneiss and schist.	25-50% & 5-20%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
34.	south and west facing mountain slopes with steep valley draws		Lithic Cryorthents	sandy-skeletal, mixed	<20"		established along Olsen Creek; low timber productivity from the Douglas fir and Lodgepole pine vegetative community. Rock outcrop of 10-25%.	30-60%
		Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
		Loberg	Typic Cryoboralfs	clayey-skeletal, mixed	>40"			
		Granile (Colo)	Typic Cryoboralfs	loamy-skeletal, mixed	>40"			
		Lolon	Pachic Cryoborolls	loamy-skeletal, mixed	20-40"			
35.	north facing moderately steep and steep mountain slopes	(t) Starman (Wyo)	Lithic Cryorthents	loamy-skeletal, mixed (calcareous)	<20"		modally contains sizeable quantities of stones and cobbles; parent rocks are generally calcareous and are of sedimentary origin. Rock outcrop of 10-30%.	30-60%
			Typic Cryochrepts	loamy-skeletal, mixed	<20"			
			Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
			Typic Cryoboralfs	loamy-skeletal, mixed	20-40"			
			Typic Cryoborolls	loamy-skeletal, mixed	20-40"			
36.	steep and very steep mountainous slopes	(t) Starman (Wyo)	Lithic Cryorthents	loamy-skeletal, mixed (calcareous)	<20"		Rock outcrop of 10-35%.	50+%
			Lithic Cryochrepts	loamy-skeletal, mixed	<20"			
			Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
			Typic Cryochrepts	loamy-skeletal, mixed	>40"			
37.	moderately steep and steep residual mountain slopes	(t) Starman (Wyo)	Lithic Cryorthents	loamy-skeletal, mixed (calcareous)	<20"		limestone and other sedimentary bedrocks. Rock outcrop of 10-25%.	20-50%
			Lithic Cryochrepts	loamy-skeletal, mixed	<20"			
		Pishkun	Typic Cryorthents	loamy-skeletal, mixed (calcareous)	20-40"			
			Typic Cryoborolls	loamy-skeletal, mixed (calcareous)				

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
38.	steep mountain uplands and valley side slopes	Gambler (moderately deep variant)	Typic Cryoboralfs	loamy-skeletal, mixed	20-40"		parent rock consists of tertiary volcanics and pre-belt materials without free carbonates.	30-60+%
		Garlet (moderately deep variant)	Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
		Gambler	Typic Cryoboralfs	loamy-skeletal, mixed	>40"			
		Garlet	Typic Cryochrepts	loamy-skeletal, mixed	>40"			
39.	moderately steep and steep mountain lands	Cowood	Lithic Cryochrepts	loamy-skeletal, mixed	<20"	U	parent rock is tertiary volcanics and pre-belt materials without free carbonates; parkland vegetation with Douglas fir dominating the timber species.	30-60%
			Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
			Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
			Typic Cryoborolls	loamy-skeletal, mixed	20-40"			
40.	hilly to mountainous glacial till uplands	Leavitt (Wyo)	Argic Cryoborolls	fine-loamy, mixed	>40"		much of unit is kettle and kame topography; Leavitt vegetation is Idaho and rough fescues, shrubby cinquefoil and bluegrasses; Loberg soils supporting stands of Douglas fir and Lodgepole pine; other soils include wet soils in potholes and along drainageways; very shallow soil and rock outcrops represent about 10% of unit; unit is from Gallatin Canyon survey by Olsen, et al.	8-40%
		Loberg	Typic Cryoboralfs	clayey-skeletal, mixed	>40"			
		Garlet	Typic Cryochrepts	loamy-skeletal, mixed	>40"	?->		

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
41.	moderately steep to steep mountainous landscapes	Teton	Typic Cryoborolls	fine-loamy, mixed	20-40" (40%)		mixed vegetative type of Lodgepole pine and Douglas fir with a park grassland type dominated by Idaho and rough fescues, mountain brome and shrubs; Rambler, Cheadle and glacial till soils similar to Leavitt and Loberg make up about 20% of unit, unit is from Gallatin Canyon survey by Olsen, et al.	15-50%
		Garlet	Typic Cryochrepts	loamy-skeletal, mixed	>40" (40%)			
		(t) Rambler (Wyo)	Typic Cryorthents	loamy-skeletal, mixed (acid)	>40"			
		Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
		Leavitt (Wyo)	Argic Cryoborolls	fine-loamy, mixed	>40"			
		Loberg	Typic Cryoboralfs	clayey-skeletal, mixed	>40"			
42.	hogback strike ridges and moderately steep and steep uplands	Kildor (Colo)	Typic Cryoborolls	fine, montmorillonitic	20-40"		established on high elevation portion of Battle Ridge; Kildor and Teton series have cambic horizons; some, but not all, soils underlain with "lithic" type of bedrock.	15-45%
		Owen Creek (Wyo)	Argic Cryoborolls	fine, montmorillonitic	20-40"			
		Teton	Typic Cryoborolls	fine-loamy, mixed	20-40"			
		Doby	Typic Cryoborolls	clayey, montmorillonitic, shallow	<20"			
		(t) Dra (Ida)	Argic Cryoborolls	fine-loamy, mixed	20-40"			
43.	rolling and moderately steep mountainous uplands		Typic Cryoborolls	fine-loamy, mixed	>40"		cobbly and stony phases are frequently found; shrub-grassland type of vegetative cover; primarily developed for use in tertiary volcanics and pre-belts but may contain small inclusions of materials containing free carbonate; established in Gravelly range.	10-35%
			Pachic Cryoborolls	fine-loamy, mixed	>40"			
			Pachic Cryoborolls	loamy-skeletal, mixed	>40"			
			Typic Cryoborolls	loamy-skeletal, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
44.	nearly level valley terraces	Huffine	Argic Cryoborolls	fine-silty over sandy or	>40"		parent material consists of loess mantle over outwash gravels; silt loam and gravelly loam types are included.[2]	0-5%
45.	valley terraces and stream bottoms		Argiaquic Cryoborolls	fine-silty, mixed	>40"		parent material consists of a loess mantle over outwash gravels in stream bottoms; silt loam type; called poorly drained phase of Huffine in Gallatin Valley soil survey.	0-5%
46.	southerly exposures of moderately steep and steep residual foothills	Maurice Libeg Lolon	Typic Cryoborolls Argic Cryborolls Pachic Cryoborolls	loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed	>40" >40" 20-40"		bouldery phases of all three series predominate; established in open sagebrush dominated areas in vicinity of the South Meadow Creek Ranger Station, SE portion of Tobacco Roots; parent rock is tertiary voncanics and pre-belt materials	20-50%
47.	very smooth steep mountain slopes	Brickel (Wash) (calcareous mineralogy variant)	Typic Cryoborolls	loamy-skeletal, mixed	20-40"			20-60%
		Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
48.	mountainous foothills of high elevation on rolling and moderately steep slopes		Typic Cryoborolls Lithic Cryoborolls Argic Cryoborolls	fine-loamy, mixed fine-loamy, mixed fine-loamy, mixed	20-40" <20" 20-40"		parent rock is recent volcanics and slope wash from other igneous rocks lacking free carborates; includes some pre-belt materials; from Virginia City and Ennis area	4-20%

[2] Mapping and unit definition largely adapted from Soil Survey of the Gallatin Valley Area, Montana, U.S. Soil Conservation Service (1931).

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
49.	high valley terraces and alluvial fans	Bozeman	Argic Pachic Cryoborolls	fine-silty, mixed	>40"		silt loam type; unit is from Gallatin Valley soil survey	2-15%
50.	alluvial fans and terraces facing north from foothills of Absaroka Mts.	Bridger	Argic Cryoborolls	fine, mixed	>40"		includes types of loam, gravelly loam and silty clay loam as delineated in Gallatin Valley soil survey.	2-30%
51.	alluvial fans and terraces	(p) Dearborn	Argic Cryoborolls	clayey-skeletal, mixed	>40"		called Bridger stony loam in Gallatin Valley soil survey; Dearborn is not listed in the most recent national key.	0-20%
52.	alluvial fans and terraces north from foothills of Absaroka Mts.	Charlos	Argic Cryoborolls	fine-loamy over sandy or sandy-skeletal, mixed	>40"		loam type; unit is from Gallatin Valley soil survey	0-3%
53.	moderately steep to steep mountainous land-smooth landscapes but some inclusion of steeper terrain and ledge rock outcrop	Teton Cheadle Adel Hobacker (Wyo)	Typic Cryoborolls Lithic Cryoborolls Pachic Cryoborolls Pachic Cryoborolls	fine-loamy, mixed loamy-skeletal, mixed fine-loamy, mixed loamy-skeletal, mixed	20-40" (65%) <20" (10%) >40" >40"		vegetation consists of Idaho and rough fescues, mountain brome, shrubby cinque foil; Cheadle soils are found on the convex slopes along ridges and knobs; Teton series occurs on the long smooth slopes between the ridges and drainageways; Hobacker and Adel are common along creeks; rock outcrop is usually associated with the Cheadle soils along ridges and hills; unit is from Gallatin Canyon survey by Olsen, et al.	10-40%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
54.	valley floors and lower reaches of alluvial/colluvial fans	Tampico (NM)	Typic Cryoborolls	fine-loamy, mixed	>40"		established in the Gravelly Mts.	0-8%
		Maurice	Typic Cryoborolls	loamy-skeletal, mixed	>40"			
		Adel	Pachic Cryoborolls	fine-loamy, mixed	>40"			
		Lolon	Pachic Cryoborolls	loamy-skeletal, mixed	>40"			
55.	moderately steep to steep mountainous uplands	Leavitt (Wyo)	Argic Cryoborolls	fine-loamy, mixed	>40"		grassland vegetative tyne dominated by Idaho and rough fescues, bluegrasses, sagebrush and other shrubs on undulating to steep glacial till uplands; commonly found midway between the forested till areas and the valley terraces; Leavitt stony loam is the dominant soil type and is found on the sloping lands between the ridges and the drainageways and concave areas. Hanson very cobbly and stony soils are found on the ledges; Adel, Michelson and Hobacker comprise about 10% of unit; unit is from Gallatin Canyon survey by Olsen, et al.	8-35%
		Hanson	Calcic Cryoborolls	loamy-skeletal, carbonatic	>40"			
		Adel	Pachic Cryoborolls	fine-loamy, mixed	>40"			
		Michelson	Argic Cryoborolls	fine-loamy, mixed	>40"			
		Hobacker (Wyo)	Pachic Cryoborolls	loamy-skeletal, mixed	>40"			
56.	moderately steep short alluvial fans generally in uplands	Burnette	Argic Pachic Cryoborolls	fine, montmorillonitic	>40"		established in Bridger Mts.; the fine families are generally dominant with Burnette being the most important series; some aspen and Douglas fir, but probably disturbed; well developed shrub understory; shale derived soils with small inclusion of 30-40" to bedrock analogs.	7-30%
		(t) Sangrey	Argic Pachic Cryoborolls	fine-loamy, mixed	>40"			
		Adel	Pachic Cryoborolls	fine-loamy, mixed	>40"			
			Pachic Cryoborolls	fine, mixed	>40"			
		(p) Dearborn	Argic Cryoborolls	clayey-skeletal, mixed	>40"			
		Bridger	Argic Cryoborolls	fine, mixed	>40"			
		Owen Creek (Wyo)	Argic Cryoborolls	fine, montmorillonitic	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
57.	undulating to rolling high elevation grassed uplands	Leavitt (Wyo)	Argic Cryoborolls	fine-loamy, mixed	>40"	A	Redlodge is found in swale heads and in the shallow, branched stream valleys; bedrock outcrops occur on a few hills and knolls; associated Lithic Cryoborolls comprise less than 5%; Bridger was found as a component of the association in the west fork of Sage Creek; unit is from Gallatin Canyon survey by Olsen, et al.	3-15%
		Blaine (deep variant)	Argic Cryoborolls	loamy-skeletal, mixed	>40"			
		Redlodge	Cumulic Cryaquolls	fine, mixed	>40"			
		Bridger	Argic Cryoborolls	fine, mixed	>40"			
58.	hilly and mountainous high elevation, uplands	Blaine	Argic Cryoborolls	loamy-skeletal, mixed	20-40"	A	includes 15-35% outcrops of gneiss and schist; Cheadle identified is non-typical in that it is underlain with gneiss and schist instead of an indurated sandstone; Redlodge comprising about 5% of landscape is continuous from swale heads and all shallow branched stream valleys.	15-45%
		Blaine (deep variant)	Argic Cryoborolls	loamy-skeletal, mixed	>40"			
		Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
		Redlodge	Cumulic Cryaquolls	fine, mixed	>40"			
		Adel	Pachic Cryoborolls	fine-loamy, mixed	>40"			
		Lucky (Colo)	Argic Cryoborolls	fine-loamy, mixed	20-40"			
59.	sloping fans, nearly level terraces and floodplains	Libeg	Argic Cryoborolls	loamy-skeletal, mixed	>40" (25%)		terrace slopes 1-5%, fan slopes 5-35%; Libeg and Bearmouth soils are closely associated on second and third terraces; Hobacker soils occupy the short fans; Michelson soils are on the highest valley terraces bordering the uplands; unit is from Gallatin Canyon survey by Olsen, et al. Gravelly alluvial land of 20%.	0-35%
		Hobacker (Wyo)	Pachic Cryoborolls	loamy-skeletal, mixed	>40" (25%)			
		Bearmouth	Typic Cryoborolls	sandy-skeletal, mixed	>40" (10%)			
		Michelson	Argic Cryoborolls	fine-loamy, mixed	>40" (10%)			
		(t) Kissick	Vertic Cryoborolls	fine, montmorillonitic	>40" (2%)			
		(t) Tonks (Ida)	Typic Cryaquolls	fine-loamy, mixed (calcareous)	>40" (2%)			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
60.	steep high mountain uplands		Argic Cryoborolls	fine-loamy, mixed	20-40"	A	grass - shrub vegetative type; on granite and pre-belt rocks; Hazton has been correlated to Cheadle (Lithic Cryoborolls, loamy-skeletal, mixed) by the Montana SCS.	20-60%
		Carbon (Colo)	Argic Lithic Cryoborolls	loamy, mixed	<20"			
		Hazton (Wyo)	Lithic Cryoborolls	loamy, mixed	<20"			
			Lithic Cryoborolls	sandy-skeletal, mixed	<20"			
61.	highly eroded foothills	Blaine	Argic Cryoborolls	loamy-skeletal, mixed	20-40"	A	parent rock is basalt and other relatively recent volcanics including sizeable amounts of breccias; inclusion of a sequence of series which are gravelly and stony subsoil phases of Argic Cryoborolls; fine-loamy, mixed;	10-60%
		Libeg	Argic Cryoborolls	loamy-skeletal, mixed	>40"			
		Rooset (Wyo)	Argic Cryoborolls	clayey-skeletal, montmorillonitic	>40"			
		Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
		(p) Dearborn	Argic Cryoborolls	clayey-skeletal, mixed	20-40"			
62.	high elevation rolling and undulating residual mountain uplands	Nielsen (Ida)	Argic Lithic Cryoborolls	loamy-skeletal, mixed	<20"		crystalline bedrock outcrop and very shallow soils comprise 10-25% of the association; soils deeper than 40" comprise 15-35% of the association.	3-15%
			Argic Cryoborolls	clayey-skeletal, mixed	20-40"			
			Argic Cryoborolls	fine, mixed	20-40"			
		Blaine	Argic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Leavitt (Wyo)	Argic Cryoborolls	fine-loamy, mixed	>40"			
		Bridger	Argic Cryoborolls	fine, mixed	>40"			
64.	hanging valleys with sloping benches	Skaggs	Calcic Cryoborolls	loamy-skeletal, carbonatic	20-40"		parkland type with Douglas fir and Limber pine as dominant timber types. Rock outcrop of 10-35%.	10-30%
		Hanson	Calcic Cryoborolls	loamy-skeletal, carbonatic	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
65.	moderately steep and steep slopes of the mountain flank and strike ridges	Skaggs	Calcic Cryoborolls	loamy-skeletal, carbonatic	20-40"		established in Gravelly Mts. Rock outcrop (limestone) of 5-30%.	8-75%
		Duncom (Wyo)	Lithic Cryoborolls	loamy, mixed	<20"			
		Hanson	Calcic Cryoborolls	loamy-skeletal, carbonatic	>40"			
		Whitore	Typic Cryochrepts	loamy-skeletal, carbonatic	>40"			
66.	moderately steep slopes of the mountain flank which are transitional to the valley floor	Hanson	Calcic Cryoborolls	loamy-skeletal, carbonatic	>40"		stunted Douglas fir stands without closed canopy; stony and cobbly phases are dominant; established in Gravelly Mts.	20-50%
		Kitchell(Utah)	Calcic Pachic Cryoborolls	loamy-skeletal, carbonatic	>40"			
		(t) Richvale (Ida)	Calcic Pachic Cryoborolls	fine-loamy, mixed	>40"			
		Raynesford	Calcic Cryoborolls	fine-loamy, carbonatic	>40"			
		Rentsac	Lithic Ustic Torriorthents	loamy-skeletal, mixed (calcareous), frigid	<20"			
67.	north facing moderately steep slopes	Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"		dominated by shrubs and grassland with some conifers and aspen in the swails; parent rock of Boulder batholith and pre-belt rocks. Rock outcrop of <10%.	20-50%
		Brickel (Wash)	Typic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Nielsen (Ida)	Argic Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
			Argic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Adel	Pachic Cryoborolls	fine-loamy, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
68.	moderately steep dissected uplands	(t) Mucet	Lithic Cryoborolls	loamy, mixed	<20"			20-50%
		Saw creek (Wyo) (mineralogy variant)	Typic Cryoborolls	coarse-loamy, mixed	20-40"			
		Shook	Pachic Cryoborolls	coarse-loamy, mixed	20-40"			
		Lucky (Colo)	Argic Cryoborolls	fine-loamy, mixed	20-40"			
69.	moderately steep and steep dominantly south facing slopes-smooth and uniform slopes		Lithic Cryoborolls	fine-loamy, mixed	<20"		nearly complete shrub and grass cover.	30-60+%
			Argic Lithic Cryoborolls	fine-loamy, mixed	<20"			
			Typic Cryoborolls	fine-loamy, mixed	20-40"			
70.	hilly and mountainous, stream-dissected rocky uplands at high elevations	Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"	A	parent rock and very shallow soils comprise 40-60% of the association; bedrock outcrop of gneiss and schist but regolith is carbonatic.	30-60%
		Merino (calcareous variant)	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"			
		Brickel (Wash) (calcareous variant)	Typic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Blaine	Argic Cryoborolls	loamy-skeletal, mixed	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
71.	very steep smooth slopes in high elevation uplands	Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"		bedrock outcrop and very shallow soils comprise 20% of association; parent rock consists of generally calcareous sedimentary rocks.	30-60%
		Merino	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"			
		Brickel (Wash) (calcareous variant)	Typic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Blaine	Argic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Nielsen (Ida)	Argic Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
72.	valley floors including floodplains and lower portions of alluvial/colluvial slopes	Lolon	Pachic Cryoborolls	loamy-skeletal, mixed	>40"		Adel generally found as a gravelly or stony phase; parent rock is either Boulder batholith or pre-belt rocks which are non-calcareous.	7-30%
		Brickel (Wash)	Typic Cryoborolls	loamy-skeletal, mixed	20-40"			
		Adel	Pachic Cryoborolls	fine-loamy, mixed	>40"			
A72.	valley floors, flood-plains and lower portions of alluvial fans and valley sides		Calcic Cryoborolls	loamy-skeletal, mixed	>40"		inclusions of analogs of loamy-skeletal or fine-loamy designations; timber and some shrub/grassland type with well developed understory; large boulders and stones present in some locations.	3-25%
			Typic Cryoborolls	loamy-skeletal, mixed	>40"			
			Typic Cryoborolls	fine-loamy, mixed	>40"			
			Pachic Cryoborolls	loamy-skeletal, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
73.	floodplains, low terraces and toes of alluvial fans including some materials deposited by mass movement	Adel	Pachic Cryoborolls	fine-loamy, mixed	>40"		gravelly and stony phases present with inclusions of loamy-skeletal analogs; there are some isolated bedrock outcrops along the escarpments to the creek but they do not compose a significant portion of the unit; established in the Tom Minor Basin	0-15% but includes some escarpments from terraces and fans to the floodplains
		Leavitt (Wyo)	Argic Cryoborolls	fine-loamy, mixed	>40"			
			Fluventic Cryoborolls	fine-loamy, mixed	>40"			
		Outlet (Ida)	Aquic Cryoborolls	fine-loamy, mixed	>40"			
A73.	moderately steep to steep residual uplands and alluvial/colluvial fans		Typic Cryoborolls	fine-loamy, mixed	20-40"		inclusion of Argic Pachic Cryoborolls, fine-loamy, mixed; depth restriction is to paralithic contact, but there is an inclusion of lithic types primarily from igneous rocks; established in Tom Miner Basin.	25-60%
			Argic Cryoborolls	fine-loamy, mixed	20-40"			
			Argic Cryoborolls	fine-loamy, mixed	>40"			
			Argic Cryoborolls	fine, mixed	>40"			
74.	older terraces and alluvial fans	(t) Packsaddle (Ida)	Argic Pachic Cryoborolls	fine-loamy, mixed			inclusion of Typic Cryoborolls on steeper slopes; Aquic Cryoborolls are moderately extensive and important in the management of this unit; inclusion of 10-14% slope on higher reaches of fans; established in Tom Miner Basin.	3-10%
		Burnette	Argic Pachic Cryoborolls	fine, montmorillonitic				
		Leavitt (Wyo)	Argic Cryoborolls	fine-loamy, mixed	>40"			
		(t) Outlet (Ida)	Aquic Cryoborolls	fine-loamy, mixed				

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo- sition	Unit Type*	Descriptive Notes	Slope Range
A74.	residual uplands morainal deposits and slump materials		Argic Cryoborolls Argic Cryoborolls Typic Cryoborolls Aquic Cryochrepts	fine-loamy, mixed fine-loamy, mixed fine-loamy, mixed fine-loamy, mixed	20-40" >40" 20-40" >40"		inclusion of Typic Cryoborolls with A/C profiles; Aquic Cryochrepts are dominated by Aspen; established in Tom Miner Basin.	25-60%
75.	older terraces and alluvial fans		Argic Cryoborolls Argic Cryoborolls Argic Cryoborolls Aquic Cryoborolls Typic Cryoborolls	fine-loamy, mixed coarse-loamy, mixed fine-loamy, mixed fine-loamy, mixed fine-loamy, mixed	>40" >40" 20-40" >40" 20-40"		loamy-skeletal analogs are found for many of the series with some cobbles and boulders in major drainageways; established in Tom Miner Basin.	7-35%
A75.	steep residual escarpment occupying the position between the moderately steep uplands and the alluvial fans of the valley		Lithic Cryoborolls Lithic Cryochrepts Typic Cryoborolls Typic Cryochrepts Typic Argiborolls Typic Cryochrepts	loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed	<20" <20" 20-40" 20-40" >40" >40"		fine-loamy, and less frequently, coarse-loamy analogs are present but are most frequently found as gravelly and stony phases; minor inclusion of a Cryoboralf; established in Tom Miner Basin.	30-60%
76.	moderately steep and rolling mountain uplands including cirque lakes and basins and the steeper walls	Cowood Devore (Wash) Evaro Tenex	Lithic Cryochrepts Typic Cryochrepts Typic Cryaquepts Typic Cryorthods Typic Cryorthods	loamy-skeletal, mixed loamy-skeletal, mixed fine-silty, mixed loamy-skeletal, mixed loamy-skeletal, mixed	<20" 20-40" >40" 20-40" >40"	A	Aquepts and Orthods largely restricted to the flatter slopes; rock outcrop of 15%.	7-20% & 40-60+%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
81.	alluvial floodplains	Larry	Typic Haplaquolls	fine-loamy, mixed, frigid	>40"	U	wide range in degree of wetness; includes some peat, muck and marshland; the current national key lists Somers as a Udic Haploboroll, but the Montana SCS lists both as a Udic Haploboroll and an Aquic Haploboroll (same family in both cases).	0-2%
		Somers	Aquic Haploborolls	fine-silty over sandy or sandy-skeletal, mixed	>40"			
		(t) Canninger (Wyo)	Cumulic Haplaquolls	fine-loamy, mixed (calcareous), frigid	>40"			
85.	floodplains, oxbows, and some naturally impounded wetlands	(t) Rista	Typic Fluvaquents	coarse-loamy, mixed (calcareous), frigid	>40"	A	marshland; islands of Scravo occur; Rista occurs with a sandy substrata in the Dillon area; Flat Willow has been correlated to Fairdale (ND - Mollic Udifluvents, fine-loamy, mixed, frigid) by the Montana SCS.	0-2%
		(t) Hagga	Typic Fluvaquents	fine-loamy, mixed (calcareous), frigid	>40"			
		Rivra	Ustic Torrifluvents	sandy-skeletal, mixed, frigid	>40"			
		Flat Willow	Aquic Fluventic Haploborolls	coarse-loamy over sandy or sandy-sekeltal, mixed	20-40"			
90.	toe slopes and swails in residual uplands	Regent	Typic Argiborolls	fine, montmorillonitic	20-40"	A	dominant capability class III and IV; generally cultivated; inclusion of Roundup, Cabba, and Wayden with fine families dominating.	3-15%
		Savage	Typic Argiborolls	fine, montmorillonitic	>40"			
		Reeder (ND)	Typic Argiborolls	fine-loamy, mixed	20-40"			
		Farnuf	Typic Argiborolls	fine-loamy, mixed	>40"			
			Typic Argiborolls	fine, montmorillonitic	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
91.	moderately steep fans and toe slopes at contact with the residual uplands	Hilger Circleville (Utah)	Typic Argiborolls Typic Argiborolls Typic Argiborolls	loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed	>40" 20-40" 20-40"		some minor inclusion of rock outcrop and Lithic Haploborolls; Circleville is non-typical because of the presence of underlying sedimentary bedrocks rather than the volcanic agglomerates described as typical for the series; unit from the mapping of Livingston by Haigh.	2-30%
92.	floodplains and low terraces	Bitton Riverside Somers	Entic Haploborolls Entic Haploborolls Aquic Haploborolls	loamy-skeletal, mixed sandy-skeletal, mixed fine-silty over sandy or sandy-skeletal, mixed	>40" >40" >40"	U	extensive occurance of river wash including many gravel bars; Bitton is called Hyrum gravelly loam in Gallatin Valley soil survey; Riverside and Somers called Riverwash in Gallatin Valley soil survey; Somers is listed in the national key as a Udic Haploboroll, but the Montana SCS has it as both an Aquic and a Udic Haploboroll.	0-2%
93.	upland fans and terraces mantled with aeolian sediments	Manhattan Lambert	Typic Calciborolls Typic Ustorthents Typic Ustorthents	coarse-loamy, mixed coarse-loamy, mixed (calcareous), frigid fine-silty, mixed (calcareous), frigid	>40" >40" >40"	A	very fine sandy loam, fine sandy loam and silt loam types are included; unit from Gallatin Valley soil survey.	0-15%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
94.	residual uplands with aeolian mantle	Dast	Typic Ustorthents Typic Haploborolls Typic Calciborolls	coarse-loamy, mixed (calcareous), frigid fine-silty, mixed, shallow fine-silty, mixed, shallow	20-40" <20" <20"	A	soils underlain by calcareous laminated sandstone at depths of 15-25 inches; Typic Calciboroll is called Manhattan very fine sandy loam, shallow phase, in Gallatin Vallev soil survey.	0-15%
95.	low valley terraces		Typic Haploborolls	fine-silty over sandy or sandy-skeletal, mixed	>40"		called Millville silt loam in Gallatin Valley soil survey.	0-10%
96.	strike ridges and moderately steep to steep alluvial/ colluvial slopes	Reeder (ND) Castner (t) Roundup Circleville (Utah) (mineralogy variant)	Typic Argiborolls Lithic Haploborolls Typic Argiborolls Typic Haploborolls Typic Argiborolls	fine-loamy, mixed loamy-skeletal, mixed fine, montmorillonitic fine-loamy, mixed loamy-skeletal, mixed	20-40" <20" 20-40" 20-40" 20-40"	U	Circleville is non-typical because of the presence of underlying sedimentary bedrocks rather than the volcanic agglomerates described as typical; from the mapping of Livingston area by Haigh.	8-35%
97.	outwash terraces	Farnuf Savage (t) Len Lennep	Typic Argiborolls Typic Argiborolls Typic Argiborolls Glossic Natriborolls	fine-loamy, mixed fine, montmorillonitic clayey over loamy-skeletal, mixed fine, montmorillonitic	>40" >40" 20-40" >40"	A	all series are also found as gravelly phases.	2-15%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
98.	outwash terraces	Perma	Typic Haploborolls	loamy-skeletal, mixed	>40"		Farnuf and Martinsdale are underlain with loamy-skeletal materials at depths of 20-40" and in some instances 40".	2-10%
		Hilger	Typic Argiborolls	loamy-skeletal, mixed	>40"			
		Farnuf	Typic Argiborolls	fine-loamy, mixed	>40"			
		Martinsdale	Typic Argiborolls	fine-loamy, mixed	>40"			
99.	residual uplands	Regent	Typic Argiborolls	fine, montmorillonitic	20-40"		Cargill has been classified as a Borollic Calciorthids, fine-silty, mixed in the most recent national key representing a change from the Classification of Active Soil Series of Montana.	0-18%
		Trulon	Typic Calciborolls	fine-loamy, carbonatic	20-40			
		Cargill	Borollic Calciorthids	fine-silty, carbonatic	20-40"			
		Avalanche	Borollic Calciorthids	fine-silty, mixed	>40"			
100.	steep residual uplands		Lithic Haploborolls	loamy, carbonatic	<20"		unit is on limestone with unorganized rock outcrop in steep limestone ledges.	25-40%
			Lithic Ustorthents	loamy, carbonatic, frigid	<20"			
		Maiden	Typic Calciborolls	loamy-skeletal, carbonatic	20-40"			
101.	residual uplands	Maiden	Typic Calciborolls	loamy-skeletal, carbonatic	20-40"	U	unit is on limestone and shale.	5-18%
		Fairfield	Typic Arbigorolls	fine-loamy, mixed	>40"			
		Judith	Typic Calciborolls	fine-loamy, carbonatic	>40"			
			Lithic Haploborolls	loamy, carbonatic	<20"			
		Regent	Typic Argiborolls	fine, montmorillonitic	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
102.	steep lands along Madison River with bedrock outcrops and variable mantles of gravelly alluvium, loess, and aeolian sands	Castner Maiden Musselshell	Lithic Haploborolls Lithic Haploborolls Typic Calciborolls Borollic Calciorthids	loamy-skeletal, mixed loamy, carbonatic loamy-skeletal, carbonatic coarse-loamy, carbonatic	<20" <20" 20-40" >40"		unit includes 1-10% bedrock outcrop of limestone and non-crystaline igneous rocks on 15-35% slopes; unit is from Gallatin Valley soil survey.	15-35%
103.	high valley terraces	Ashuelot Windham Utica	Petrocalcic Calciborolls Typic Calciborolls Typic Calciborolls	loamy, carbonatic, shallow loamy-skeletal, carbonatic sandy-skeletal, carbonatic	<20" to caliche >40" to bedrock >40"	A	Ashuelot appears on smooth gently sloping areas with Windham and Utica appearing on increasingly steep slopes; unit is from Gallatin Valley soil survey.	2-15%
104.	valley terraces	Beaverton	Typic Argiborolls	loamy-skeletal, mixed	>40"		Beaverton is listed as a gravelly loam type in the Gallatin Valley soil survey.	0-3%
105.	valley terraces	Turner Beaverton	Typic Argiborolls Typic Argiborolls	fine-loamy over sandy or sandy-skeletal, mixed loamy-skeletal, mixed	>40"	U	Turner is called Beaverton loam in Gallatin Valley soil survey; Beaverton loam occurs undifferentiated in the delineation.	0-3%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
106.	loess-mantled high valley terraces and alluvial fans	Farland (ND) Lambert	Typic Argiborolls Pachic Argiborolls Typic Ustorthents	fine-silty, mixed fine-silty, mixed fine-silty, mixed (calcareous), frigid	>40"	A	Farland is called Bozeman, brown phase in Gallatin Valley soil survey; Lambert appears as light brown areas on dominant slope range of 8-15%; Pachic Argiborolls appear on mid and lower valley slopes of dendritic drainage pattern.	2-15%
107.	alluvial fan terraces facing west from foothills of Bridger Mts.	Danvers	Typic Argiborolls	fine, montmorillonitic	>40"		called Bridger in Gallatin Valley soil survey; mean summer soil temperature estimated at 62°F.	2-30%
108.	loess-mantled valley terrace plains	Amsterdam Lambert	Typic Cryoborolls Typic Ustorthents	fine-silty, mixed fine-silty, mixed (calcareous), frigid	>40" >40"	A	Lambert appears as light brown areas on dominant slope range of 8-15%; unit is from Gallatin Valley soil survey.	0-15%
109.	outwash terraces	(p) Lithco Bitton Datino (Utah) Hilger Beaverton	Typic Ustorthents Entic Haploborolls Typic Haploborolls Typic Argiborolls Typic Argiborolls	loamy-skeletal, mixed (calcareous), frigid loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed	>40" >40" >40" >40" >40"	U	Lithco is not listed in the most recent national key; inclusion of some soils having sandy-skeletal control sections; gravels and cobbles of mixed lithologies as an outwash from local physical weathering and glaciation; Hilger and Beaverton have considerable range in the gravel and cobble content of the upper 12"; unit established in Paradise Valley.	0-15%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
110.	residual uplands having steep limestone strike ridges variably spaced with sloping intervening soil areas	Maiden	Lithic Haploborolls Lithic Ustorthents Typic Calciborolls	loamy, carbonatic loamy, carbonatic, frigid loamy-skeletal, carbonatic	<20" <20" 20-40"	A	prominent steep rock outcrop comprising 10% of area; Typic Calciborolls comprising 50% of area on 5-10% slopes.	5-35%
111.	glaciated and outwash plains - channeled scabland appearance with morainal basins	(p) Lithco Bitton Datino (Utah) Hilger	Typic Ustorthents Entic Haploborolls Typic Haploborolls Typic Argiborolls Typic Argiborolls	loamy-skeletal, mixed (calcareous), frigid loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed	>40" >40" >40" >40" >40"	A	Lithco is not listed in the most recent national key; gravels and boulders of mixed lithologies as an outwash from local physical weathering and glaciation which overlies basalt at varying depths; inclusion of some soils having sandy-skeletal control sections; some evidence of larger drainage or channel establishment; unit contains some closed morainal basins; unit established in Paradise Valley.	0-30%
112.	basalt capped steep escarpments	Perma Bitton (p) Lithco	Typic Haploborolls Entic Haploborolls Typic Ustorthents	loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed (calcareous), frigid	>40" >40" >40"	A	Lithco is not listed in the most recent national key; inclusion of Zahill and Quigley soil series; rock outcrop occupies only a small percentage of unit but dominated the geomorphic development and visual aspect; considerable colluvial action involved in development of unit. Rock outcrop of 5-20%.	15-60+%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
113.	low terraces, alluvial fans, and smaller alluvial floodplains	Tally Korchea (ND) Shambo (ND) Straw Farnuf Two Dot	Typic Haploborolls Fluventic Haploborolls Typic Haploborolls Cumulic Haploborolls Typic Argiborolls Typic Haploborolls	coarse-loamy, mixed fine-loamy, mixed, frigid fine-loamy, mixed fine-loamy, mixed fine-loamy, mixed fine, mixed	>40" >40" >40" >40" >40" >40"		Korchea is listed as Mollic Ustifluvents, fine-loamy, mixed (calcareous), frigid in the national key; Two Dot is classified as both fine, mixed and fine-loamy, mixed (Typic Haploborolls) in Classification of Active Soil Series of Montana; loamy-skeletal materials are found and designated as gravelly and stony subsoil phases (20-40") in some locations.	0-7%
114.	alluvial fan terraces sloping west from Bridger Mts.	Roy	Typic Argiborolls	clayey-skeletal, mixed	>40"		area north of East Gallatin River called Bridger stony loam in Gallatin Valley soil survey.	0-20%
115.	river floodplains and low terraces	(p) Libra	Fluventic Haploborolls	coarse-loamy, mixed	>40"		Libra has been correlated to Trembles (Typic Ustifluvents, coarse-loamy, mixed (calcareous) frigid) by the Montana SCS; Libra is called Havre fine sandy loam, dark colored phase in the Gallatin Valley soil survey.	0-2%
116.	low terraces	Arnegard (ND)	Pachic Haploborolls	fine-loamy, mixed	>40"		Arnegard is called Gallatin in the Gallatin Valley soil survey; unit contains some loam and silty clay loam types.	0-2%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
117.	low terraces	Larry	Typic Haplaquolls Cumulic Haplaquolls Hemic Borofibrists Typic Borohemists	fine-loamy, mixed, frigid fine-loamy, mixed (calcareous), frigid	>40"	U	Larry is called Gallatin, swampy phase in Gallatin Valley soil survey.	0-2%
118.	morainal materials	Datino (Ut) Hilger Lolo (t) Agner (Colo)	Typic Haploborolls Typic Argiborolls Pachic Haploborolls Pachic Argiborolls	loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed fine-loamy, mixed	>40" >40" >40" >40"		coarse particles include some boulders up to 12-20 feet in diameter; unit has a complex slope system which frequently lacks a well defined outlet; Agner series has considerable gravel in the surface horizons; unit established on Madison River south of Ennis Lake.	15-40%
119.	floodplains and low terraces	Straw Korchea (ND) Farnuf Hilger	Cumulic Haploborolls Fluventic Haploborolls Typic Argiborolls Typic Argiborolls	fine-loamy, mixed fine-loamy, mixed, frigid fine-loamy, mixed loamy-skeletal, mixed	>40" >40" >40" >40"	U	Korchea is listed as Mollic Ustifluvents, fine-loamy, mixed (calcareous), frigid in the national key; Farnuf is underlain with loamy-skeletal materials which are not contrasting and encompass a gravelly phase in many locations; escarpments are included between the low terraces and floodplains.	0-5%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
120.	alluvial floodplains and lower portions of associated outwash fans	Riverside (t) Nesda Winetti (Ut) Bitton	Entic Haploborolls Typic Ustifluvents Typic Ustifluvents Entic Haploborolls	sandy-skeletal, mixed sandy-skeletal, mixed, frigid loamy-skeletal, mixed (calcareous), frigid loamy-skeletal, mixed	>40" >40" >40" >40"	U	unit includes some mine wastes; made land materials are in area of "Old Chico"; large inclusions of active stream channel; some cobbly and boudlery phases included; unit established in Paradise Valley and Upper Yellowstone; Nesda has been established and classified as Fluventic Haploborolls, sandy-skeletal, mixed in the most recent (6-75) national key which is a change from The Classification of Active Soil Series of Montana.	0-10%
121.	steeper slopes of alluvial fans at base of mountains	Bitton Datino (Ut) Hilger. (t) Redthayne (Wyo)	Entic Haploborolls Typic Haploborolls Typic Argiborolls Aridic Haploborolls	loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed loamy-skeletal, mixed	>40" >40" >40" >40"		unit established near Jack Creek on Madison River drainage northeast of Ennis.	5-18%
122.	aeolian mantled gravelly uplands	Manhattan	Typic Calciborolls Typic Ustorthents	coarse-loamy, mixed coarse-loamy, mixed (calcareous), frigid	>40"		gravelly types of soils prevail; mapping is from the Gallatin Valley soil survey.	0-15%
123.	terraces		Typic Calciborolls Aridic Argiborolls Aridic Argiborolls	loamy-skeletal, mixed loamy-skeletal, mixed fine-loamy, mixed	40" 40" 40"		generally cultivated	4-12%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
124.			Aridic Haploborolls	loamy-skeletal, mixed	>40"			
			Aridic Calciborolls	loamy-skeletal, mixed	>40"			
			Typic Ustorthents	loamy-skeletal, mixed (calcareous)				
125.	eroded valley terraces and fans	Crago (mixed mineralogy variant)	Borollic Calciorthids	loamy-skeletal, mixed	>40"		Molese, which has been designated as Aridic Haploborolls, loamy-skeletal, mixed, has been correlated by the Montana SCS to Riverside; Molese has been dropped in the current national key and no correlation can be suggested; unit has had relatively recent surface erosion with associated wide variation in surface fine material resulting in a complex soil pattern; small portions of the unit are cultivated and are generally related to the Beaverell series.	2-8%
		Scravo	Borollic Calciorthids	sandy-skeletal, mixed	>40"			
		(t) Redthayne (Wyo)	Aridic Haploborolls	loamy-skeletal, mixed	>40"			
		(t) Molese	Aridic Haploborolls	sandy-skeletal, mixed				
		Beaverell	Aridic Argiborolls	loamy-skeletal, mixed	>40"			
		Bitton	Entic Haploborolls	loamy-skeletal, mixed	>40"			
		Riverside	Entic Haploborolls	sandy-skeletal, mixed	>40"			
126.	short alluvial fans and residual uplands		Typic Calciborolls		<20"			15-35%
			Typic Calciborolls		20-40"			
			Aridic Argiborolls		20-40"			
			Borollic Calciorthids		<20"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
127.	dissected uplands dominated by volcanics and high carbonate materials		Aridic Haploborolls	fine-loamy, mixed, shallow	<20"		the dominant units are 20" thick and are gravelly and stony phases of fine-loamy textures, underlying bedrock is of paralithic type, short broken types of slopes.	15-45%
			Aridic Haploborolls	fine-loamy, mixed	20-40"			
		Marmarth	Aridic Argiborolls	fine-loamy, mixed	20-40"			
			Borollic Calciorthids	fine-loamy, mixed	<20"			
			Borollic Calciorthids	fine-loamy, mixed	20-40"			
			Borollic Calciorthids	loamy-skeletal, mixed, shallow	<20"			
128.	steep escarpments near ridge crests		Borollic Calciorthids	loamy-skeletal, mixed				30-70%
			Typic Calciborolls	loamy-skeletal, mixed				
			Aridic Haploborolls	lomay-skeletal, mixed				
			Aridic Haploborolls	fine-loamy, mixed				
129.	alluvial fans and residual toe slopes		Aridic Haploborolls		20-40"			4-10%
			Aridic Haploborolls		>40"			
			Aridic Argiborolls		20-40"			
			Aridic Argiborolls		>40"			
			Aridic Calciborolls					

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
130.	moderately steep slopes of outwash material overlying volcanic flow		Typic Ustorthents	loamy-skeletal, mixed (calcareous), frigid	20-40"		channeled scabland appearance; steeper and shallower analog of Unit #111.	10-45%
			Typic Ustorthents	loamy-skeletal, mixed (calcareous), frigid	>40"			
			Entic Haploborolls	loamy-skeletal, mixed	20-40"			
			Entic Haploborolls	loamy-skeletal, mixed	>40"			
			Typic Haploborolls	loamy-skeletal, mixed	<40"			
			Lithic Ustorthents	loamy-skeletal, mixed	>20"			
131.	nearly level low terraces and floodplains	Evanston (Wyo)	Aridic Argiborolls	fine-loamy, mixed	>40"		a series similar to Attewan but underlain with non-contrasting loamy-skeletal materials at depths of 20-40" is also important in this unit. Korchea has a calcic horizon below the 10" level.	0-2%
		Attewan	Aridic Argiborolls	fine-loamy over sandy or sandy-skeletal, mixed frigid	>40"			
		Korchea (ND)	Fluventic Haploborolls	fine-loamy, mixed	>40"			
		Havrelon	Typic Ustifluvents	fine-loamy, mixed, (calcareous), frigid	>40"			
132.	outwash terraces and alluvial fans	Tridell	Aridic Calciborolls	loamy-skeletal, mixed	>40"		gravelly and cobbly phases occur often in this unit.	0-5%
		Evanston	Aridic Argiborolls	fine-loamy, mixed	>40"			
		Marmarth	Aridic Argiborolls	fine-loamy, mixed	20-40"			
		Beaverell	Aridic Argiborolls	loamy-skeletal, mixed	>40"			
136.	high tertiary terraces	(t) Beaverell	Aridic Argiborolls	loamy-skeletal, mixed	>40"	A	unit is largely cultivated; Beaverell and Evanston are gravelly loam types; Ethridge has gravelly loam and a gravelly clay loam phases.	2-8%
		Ethridge	Aridic Argiborolls	fine, montmorillonitic	>40"			
		Evanston (Wyo)	Aridic Argiborolls	fine-loamy, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
137.	alluvial fans	Radersburg	Aridic Argiborolls Aridic Argiborolls Aridic Argiborolls Aridic Argiborolls	fine, mixed clayey-skeletal, mixed clayey over loamy-skeletal, mixed clayey over sandy or sandy-skeletal, mixed	>40" >40" 20-40" 20-40"	U	Radersburg occurs as a cobbly loam, a cobbly loam with a skeletal substrata, and as a boundery phase	2-6%
138.	mountain foothills on non-crystaline igneous rocks	(t) Hauser	Aridic Argiborolls Lithic Argiborolls Aridic Argiborolls	fine-loamy, mixed loamy, mixed fine-loamy, mixed	20-40" <20" >40"	A	unit includes equal proportion of 40" depth soils for 85% of association with 15% non-crystaline igneous rock outcrop.	5-20%
139.	outwash terraces and fans	(t) Beaverell Evanston (Wyo) Tridell (Utah) Binna	Aridic Argiborolls Aridic Argiborolls Aridic Calciborolls Typic Calciborolls Aridic Calciborolls	loamy-skeletal, mixed fine-loamy, mixed loamy-skeletal, mixed loamy-skeletal, mixed fine-loamy over sandy or sandy-skeletal, mixed	>40" >40" >40" >40" >40"		unit is from mapping of Livingston area by Haigh	2-8%
140.	uplands on granitic bedrock	Uracca (Colo)	Aridic Argiborolls Aridic Lithic Argiborolls Aridic Argiborolls Aridic Lithic Haploborolls Lithic Ustic Torriorthents	loamy-skeletal, mixed loamy, mixed fine-loamy, mixed loamy, mixed sandy-skeletal, mixed frigid	>40" <20" 20-40" <20" <20"	A	unit contains non-calcareous profiles developed in weathered granite and locally transported granitic materials with 5-15% granitic outcrop which occurs as prominent features in the landscape.	3-15%

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
141.	steep granitic rocklands of arid mountain foothills		Aridic Lithic Argiborolls	loamy, mixed	<20"	A	non-calcareous soils differing from the soils Cca horizon on the foothills of the Ruby Range. Rock outcrop of 20-50%.	15-60%
		Uracca (Colo)	Aridic Argiborolls	loamy-skeletal, mixed	>40"			
			Lithic Ustic Torriorthents	sandy-skeletal, mixed frigid	<20"			
			Aridic Lithic Haploborolls	loamy, mixed	<20"			
			Aridic Argiborolls	fine-loamy, mixed	20-40"			
142.	rolling and moderately steep slopes on residual granite		Aridic Haploborolls	fine-loamy, mixed	<20"			10-45%
			Aridic Argiborolls	fine, mixed	<20"			
			Aridic Argiborolls	fine, mixed	20-40"			
			Aridic Argiborolls	fine-loamy, mixed	<20"			
			Ustic Torriorthents	fine-loamy, mixed, frigid	<20"			
143.	coalescing alluvial fans	Rothiemay	Aridic Calciborolls	fine-loamy, mixed	>40"			4-12%
		Tridell (Utah)	Aridic Calciborolls	loamy-skeletal, mixed	>40"			
		Binna	Aridic Calciborolls	fine-loamy over sandy or sandy-skeletal, mixed	>40"			
144.	slightly dissected terraces	Tridell (Utah)	Aridic Calciborolls	loamy-skeletal, mixed	>40"		Argiborolls found on the flatter terrace tops; loamy-skeletal soils dominated the upper reaches of the slopes; fine-loamy soils found on flatter areas, gravelly phases of the fine-loamy series are most important; unit established in Gravelly Mts.	10-30%
			Aridic Argiborolls	loamy-skeletal, mixed	>40"			
			Aridic Argiborolls	fine-loamy, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
145.	terrace breaks	Tridell	Aridic Calciborolls	loamy-skeletal, mixed	>40"		Lithco is not listed in the most recent national key; inclusion of floodplain soils; some para-lithic contact within 20-40".	15-40%
		Castner	Lithic Haploborolls	loamy-skeletal, mixed	<20"			
		(p) Lithco	Typic Ustorthents	loamy-skeletal, mixed (calcareous), frigid	>40"			
			Lithic Ustorthents	loamy-skeletal, mixed (calcareous), frigid	<20"			
		Bitton	Entic Haploborolls	loamy-skeletal, mixed	>40"			
			Typic Haploborolls	sandy-skeletal, mixed				
			Typic Ustorthents	sandy				
			Borollic Calciorthids	sandy-skeletal, mixed				
			Aridic Calciborolls	sandy-skeletal, mixed				
155.	river floodplains and low terraces	Trembles	Typic Ustifluvents	coarse-loamy, mixed (calcareous), frigid	>40"	U	Trembles is called Havre fine sandy loam in Gallatin Valley soil survey.	0-2%
156.	floodplains and low terraces of Missouri River through Horseshoe Hills	Banks (ND)	Typic Ustifluvents	sandy, mixed, frigid	>40"	U	Banks and Havrelon occur on islands within distributary channels of the river; Cherry occurs on alluvial fans on the river bottoms adjacent to the uplands; Rhoades-Straw complex occurs on low terraces in the valley.	0-6%
		Havrelon (ND)	Typic Ustifluvents	fine-loamy, mixed (calcareous), frigid	>40"			
		Cherry (ND)	Typic Ustochrepts	fine-silty, mixed, frigid	>40"			
		Rhoades (ND)	Leptic Natriborolls	fine, montmorillonitic	>40"			
		Straw	Cumulic Haploborolls	fine-loamy, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
157.	alluvial floodplains	Lohler (ND)	Typic Ustifluvents	fine, montmorillonitic (calcareous), frigid	>40"	U	Korchea is listed as Mollic Ustifluvents, fine-loamy, mixed (calcareous), frigid in the national key.	0-2%
		Havrelon (ND)	Typic Ustifluvents	fine-loamy, mixed (calcareous), frigid	>40"			
		Korchea (ND)	Fluventic Haploborolls	fine-loamy, mixed frigid	>40"			
		Straw	Cumulic Haploborolls	fine-loamy, mixed	>40"			
163.	moderately steep and steep residual uplands and strike ridges with multiple ridges and valleys	Cabba	Typic Ustorthents	loamy, mixed (calcareous), frigid, shallow	<20"	A	rock outcrop and very shallow phases of Cabba and Wayden range from 20-50% of the unit; Castner is important inclusion in some areas; bedrock is relatively soft interbedded sandstones and shales.	15-60%
		Wayden (ND)	Typic Ustorthents	clayey, montmorillonitic (calcareous), frigid, shallow	<20"			
		Winifred	Typic Haploborolls	fine, montmorillonitic	20-40"			
		(t) Roundup	Typic Haploborolls	fine-loamy, mixed	20-40"			
		Regent	Typic Argiborolls	fine, montmorillonitic	20-40"			
		Reeder (ND)	Typic Argiborolls	fine-loamy, mixed	20-40"			
164.	moderately steep residual uplands	Cabba	Typic Ustorthents	loamy, mixed (calcareous), frigid, shallow	<20"	A	largely capability Class VI and VIII, includes some Class IV; inclusion of Farnuf and Savage; fine families dominant; cultivation confined to the Winifred, Roundup, and Regent components. Rock outcrop of <10%.	10-45%
		Wayden (ND)	Typic Ustorthents	clayey, montmorillonitic (calcareous) frigid, shallow	<20"			
		Winifred	Typic Haploborolls	fine, montmorillonitic	20-40"			
		(t) Roundup	Typic Haploborolls	fine-loamy, mixed	20-40"			
		Reeder (ND)	Typic Argiborolls	fine-loamy, mixed	20-40"			
		Regent	Typic Argiborolls	fine, montmorillonitic	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
165.	steep hogback strike ridges with steeply dipping beds and some residual escarpments	Cabba	Typic Ustorthents	loamy, mixed (calcareous), frigid, shallow	<20"		largely Capability Class VII and VIII; inclusion of Regent, Reeder, and Castner; Winifred and Roundup are a small part of the unit; inclusion of very shallow phases of Cabba and Wayden; limber pine, juniper, and skunkbush plant community. Rock outcrop of 10-40%.	30-60+%
		Wayden (ND)	Typic Ustorthents	clayey, montmorillonitic (calcareous), frigid, shallow	<20"			
		Winifred	Typic Haploborolls	fine, montmorillonitic	20-40"			
		(t) Roundup	Typic Haploborolls	fine-loamy, mixed	20-40"			
166.	outwash terraces and lower portions of alluvial fans	Tinsley	Typic Ustorthents	sandy-skeletal, mixed, frigid	>40"		Molese is not listed in the most recent national key but is listed in The Classification of Active Soil Series of Montana, unit established in Madison River area south and east of Ennis.	2-8%
		(t) Molese	Aridic Haploborolls Aridic Calciborolls	sandy-skeletal, mixed sandy-skeletal, mixed				
		Attawan	Aridic Argiborolls	fine-loamy over sandy or sandy-skeletal, mixed	>40"			
		Beaverell	Aridic Argiborolls	loamy-skeletal, mixed	>40"			
		Hilger	Typic Argiborolls	loamy-skeletal, mixed	>40"			
167.	hogback or strike ridges of near vertical placement	(p) Lithco	Lithic Ustorthents	loamy-skeletal, mixed (calcareous), frigid	<20"		Lithco is not listed in the most recent national key; consider correlation with ridge south of Livingston which runs east and west; Boralfs limited to 20% of unit; dominance of shrub and grass types with 10-40% covered with limber pine, juniper, and Douglas fir (limited).	15-60%
		Dimyaw	Typic Ustorthents	fine, montmorillonitic (calcareous), frigid	>40"			
		Haugan	Typic Eutroboralfs	fine-loamy, mixed	>40"			
		(t) Roundup	Typic Haploborolls	fine-loamy, mixed	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo- sition	Unit Type*	Descriptive Notes	Slope Range
168.	aeolian mantled upland terraces and fans	Blanchard	Typic Ustipsamments	mixed, frigid	>40"	U	Blanchard is called Manhattan fine sandy loam and loamy sand in the Gallatin Valley soil survey	0-15%
			Typic Ustorthents	coarse-loamy, mixed (calcareous), frigid	>40"			
		Manhattan	Typic Calciborolls	coarse-loamy, mixed	>40"			
169.	rolling hilly and very steep arid mountains composed of non-crystalline igneous rocks	(t) Ashbon	Lithic Ustorthents	loamy-skeletal, mixed (nonacid), frigid	<20"	A	Rock outcrop of 20-50%.	15-60%
		Hauser	Lithic Argiborolls	loamy, mixed	<20"			
			Aridic Argiborolls	fine-loamy, mixed	20-40"			
170.	steep slopes into intermediate stream ways on loess mantled valley terraces	Lambert	Typic Ustorthents	fine-silty, mixed (calcareous), frigid	>40"	U	unit called rough and broken land in the Gallatin Valley soil survey; unit associated in small areas with Amsterdam and Manhattan soils.	15-30%
			Typic Ustorthents	coarse-loamy, mixed (calcareous), frigid	>40"			
171.	residual mountain uplands		Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"		established in Paradise Valley	
			Lithic Cryochrepts	loamy-skeletal, mixed (nonacid)	<20"			
			Typic Cryochrepts	loamy-skeletal, mixed (nonacid)	20-40"			
			Typic Cryorthents	loamy-skeletal, mixed (nonacid)	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
172.	residual mountain uplands		Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"		bedrock material is granitic and non-calcareous including some recent volcanics	
			Typic Cryorthents	loamy-skeletal, mixed (nonacid)	20-40"			
			Argic Cryoborolls	loamy-skeletal, mixed (nonacid)	>40"			
			Typic Cryoborolls	loamy-skeletal, mixed (nonacid)	20-40"			
174.	nearly level low terraces and flood-plains	Evanston (Wyo)	Aridic Argiborolls	fine-loamy, mixed	>40"		Korchea has calcic horizon below the 10" level.	0-2%
		Attewan	Aridic Argiborolls	fine-loamy over sandy or sandy-skeletal, mixed frigid	>40"			
		Korchea (ND)	Fluventic Haploborolls	fine-loamy, mixed	>40"			
176.	hilly remnants of tertiary age, high upland terraces having relief from 50-500 feet	Nihill (frigid variant)	Ustic Torriorthents	loamy-skeletal, mixed frigid	>40"	U	unit includes small percentage area of various types of bedrock outcrops.	20-60%
		Adilis (Colo)	Ustic Torriorthents	sandy-skeletal, mixed frigid	>40"			
		(t) Hawksell	Ustic Torriorthents	coarse-loamy, mixed (calcareous), frigid	>40"			
		Fola (Colo)	Borollic Camborthids	loamy-skeletal, mixed				
		Crago (mixed mineralogy variant)	Borollic Calciorthids	loamy-skeletal, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
177.	dissected high valley terraces	(t) Hawksell	Ustic Torriorthents	coarse-loamy, mixed (calcareous), frigid	>40"		unit includes Calciorthids on level to sloping terraces remnants.	3-20%
			Borollic Calciorthids	fine-loamy, mixed	>40"			
			Borollic Calciorthids	fine-loamy, mixed	>40"			
		(t) Diamond-ville (Wyo)	Borollic Calciorthids	fine-loamy, mixed	20-40" (20-60%)			
		Crago (mixed mineralogy variant)	Borollic Calciorthids	loamy-skeletal, mixed	>40" (40-80%)			
		Lambeth	Ustic Torriorthents	fine-silty, mixed (calcareous), frigid	>40"			
		Avalanche	Borollic Calciorthids	fine-silty, mixed	>40"			
178.	terrace breaks of valley terraces	(t) Hawksell	Ustic Torriorthents	coarse-loamy, mixed (calcareous), frigid	>40"	U	Havre and Glendive are found as inclusions in narrow stream floodplain bottoms.	15-45%
		Amesha	Borollic Calciorthids	coarse-loamy, mixed	>40"			
		Avalanche	Borollic Calciorthids	fine-silty, mixed	>40"			
		Crago (mixed mineralogy variant)	Borollic Calciorthids	loamy-skeletal, mixed	>40"			
179.	foothills and alluvial fans	(t) Pensore	Lithic Ustic Torriorthents	loamy-skeletal, carbonatic, frigid	<20"	A	50-70% of unit is hilly landscape of which rock outcrop is limy sandstone, shale, and limestone; Lithic Ustorthents comprising 20-50% of unit. Rock outcrop of 5-30%.	5-30%
			Borollic Calciorthids	fine-loamy, mixed	>40"			
		Crago (mixed mineralogy variant)	Borollic Calciorthids	loamy-skeletal, mixed	>40"			
			Ustic Torriorthents	loamy-skeletal, mixed (calcareous), frigid	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
180.	arid mountain slopes	Rentsac	Lithic Ustic Torriorthents	loamy-skeletal, mixed (calcareous), frigid	<20"	U	rock outcrop and very shallow Lithic Ustic Torriorthents comprise 20-50% of unit.	20+%
		(t) Pensore	Lithic Ustic Torriorthents	loamy-skeletal, carbonatic, frigid	<20"			
			Borollic Calciorthids	fine-loamy, mixed	>40"			
		(t) Diamond-ville (Wyo)	Borollic Haplargids	fine-loamy, mixed	20-40"			
181.	residual uplands on limestone bedrock	(t) Pensore	Lithic Ustic Torriorthents	loamy-skeletal, carbonatic, frigid	<20" (30-50%)	A	Cargill has been classified as Borollic Calciorthids, fine-silty, mixed in the most recent national key, which is a change from The Classification of Active Soil Series of Montana. Rock outcrop to 15%.	0-35%
		Cargill	Borollic Calciorthids	fine-silty, carbonatic	20-40"			
		Avalanche	Borollic Calciorthids	fine-silty, mixed	>40" (30-50%)			
		Rothiemay	Aridic Calciborolls	fine-loamy, mixed	>40"			
182.	dissected high tertiary terraces	Nihill (frigid variant)	Ustic Torriorthents	loamy-skeletal, mixed frigid	>40"	A	escarpments dominated by residual bedrock of Lithic type on plateau tops and on many steep slopes are mantled with outwash deposits; Nihill and Beaverell gravelly loam and cobbly and bouldery phases; Ethridge gravelly-loam and clay loam phases; Evanston gravelly loam phase; Argiborolls occur on tabular remnants of terraces with slopes of 5-20% with Nihill and shallow Torriorthents dominating steeper slopes and escarpments.	5-60%
		Beaverell	Aridic Argiborolls	loamy-skeletal, mixed	>40"			
		Ethridge	Aridic Argiborolls	fine, montmorillonitic	>40"			
		Evanston (Wyo)	Aridic Argiborolls	fine-loamy, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
183.	very steep residual slopes		Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"		some accumulation of fines in pockets or swails; unit established in Paradise Valley. Rock outcrop as much as 50%.	50-60+%
			Typic Cryorthents	loamy-skeletal, mixed (nonacid)	20-40			
190.	intermediate valley terraces	(t) Diamondville (Wyo)	Borollic Haplargids	fine-loamy, mixed	20-40"	A		1-3%
			Borollic Calciorthids	fine-loamy, mixed	>40"			
191.	alluvial fans, terraces and undulating upland terraces		Borollic Haplargids	fine, montmorillonitic	20-40"	U	Toby occurs as a cap in the Dillon area.	2-8%
		Amesha	Borollic Calciorthids	coarse-loamy, mixed	>40"			
		Thess	Borollic Calciorthids	fine-loamy over sandy or sandy-skeletal, mixed	>40"			
		Toby	Borollic Camborthids	coarse-loamy, mixed	>40"			
192.	low terraces	Absher	Borollic Natrargids	fine, montmorillonitic	>40"	U	Tad is not listed in the most recent national key;	0-4%
		(p) Tad	Borollic Haplargids	fine, montmorillonitic				
		Nobe	Ustic Torriorthents	fine, montmorillonitic (calcareous), frigid	>40"			
		Laurel (frigid variant)	Aquollic Salorthids	fine-loamy, mixed, frigid	>40"			
		Sage (frigid variant)	Aquollic Salorthids	fine, montmorillonitic, frigid	>40"			
		(t) Hagga	Typic Fluvaquents	fine-loamy, mixed (calcareous), frigid	>40"			
		Lallie (ND)	Typic Fluvaquents	fine, montmorillonitic (calcareous), frigid	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
193.	floodplains, alluvial fans, and some low terraces	Crago (mixed mineralogy variant)	Borollic Calciorthids	loamy-skeletal, mixed	>40"	U	Scravo and Crago occur as bouldery phases in the Dillon area.	0-8%
		Scravo	Borollic Calciorthids	sandy-skeletal, mixed	>40"			
194.	valley terraces	Scravo	Borollic Calciorthids	sandy-skeletal, mixed	>40"	A	Scravo occurs as a sandy loam and a fine sandy loam in the Dillon area; Amesha occurs as a loam and a fine sandy loam in the Dillon area.	0-8%
		Thess	Borollic Calciorthids	fine-loamy over sandy or sandy-skeletal, mixed	>40"			
		Amesha	Borollic Calciorthids	coarse-loamy, mixed	>40"			
		Avalanche	Borollic Calciorthids	fine-silty, mixed	>40"			
195.	high valley terraces	Amesha	Borollic Calciorthids	coarse-loamy, mixed	>40"	A	Amesha occurs as a loam and a fine sandy loam in the Dillon area; Avalanche occurs as a silty loam in the Dillon area; Thess occurs as a loam in the Dillon area.	2-6%
		Avalanche	Borollic Calciorthids	fine-silty, mixed	>40"			
		Thess	Borollic Calciorthids	fine-loamy over sandy or sandy-skeletal, mixed	>40"			
196.	terrace breaks, heavily dissected lower terraces, and some immediate floodplains	Crago (mixed mineralogy variant)	Borollic Calciorthids	loamy-skeletal, mixed	>40"	U	unit includes cobbly and bouldery phases of many series; suitability for agricultural production created by the amount and size of coarse particles; unit established in Madison River area.	0-5% but includes the breaks or escarpments between terraces
		Scravo	Borollic Calciorthids	sandy-skeletal, mixed	>40"			
		Beaverell	Aridic Argiborolls	loamy-skeletal, mixed	>40"			
		Havrelon (ND)	Typic Ustifluvents	fine-loamy, mixed (calcareous), frigid	>40"			
		Bitton	Entic Haploborolls	loamy-skeletal, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
197.	low terraces	Lonna	Borollic Camborthids	fine-silty, mixed	>40"	U	Thess occurs as a silty clay loam in the Dillon area; Lonna occurs as a silty loam in the Dillon area; unit includes a bouldery phase of Scravo.	0-2%
		Thess	Borollic Calciorthids	fine-loamy over sandy or sandy-skeletal, mixed	>40'			
			Typic Haplaquolls	clayey over sandy or sandy-skeletal, mixed (calcareous), frigid	>40"			
		Adilis (Colo)	Ustic Torriorthents	sandy-skeletal, mixed, frigid	>40"			
		Scravo	Borollic Calciorthids	sandy-skeletal, mixed	>40"			
		Avalanche	Borollic Calciorthids	fine-silty, mixed				
198.	distributary floodplains	Scravo	Borollic Calciorthids	sandy-skeletal, mixed	>40"	A	imperfectly drained unit; Lonna is a silt loam type occurring modally and as an imperfectly drained phase with islands of Scravo; Flat Willow has been correlated to Fairdale (ND - Mollic Udifluvents, fine-loamy, mixed, frigid) by the Montana SCS.	0-2%
		Lonna	Borollic Camborthids	fine-silty, mixed	>40"			
		Flat Willow	Aquic Fluventic Haploborolls	coarse-loamy over sandy or sandy-skeletal, mixed	20-40"			
199.	low valley terraces		Aquollic Salorthids	fine-silty, mixed, frigid.	>40"		unit called Minatare silt loam in the Gallatin Valley soil survey.	0-2%
200.			Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	<20"		bedrock intrusions of less than 15%.	
			Typic Cryorthents	loamy-skeletal, mixed (nonacid)	20-40"			
			Typic Cryochrepts	loamy-skeletal, mixed	20-40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Composition	Unit Type*	Descriptive Notes	Slope Range
206.	steep to very steep mountainous lands, sharp ridges separated by deep cut canyons	Garlet	Typic Cryochrepts	loamy-skeletal, mixed	>40" (65%)		vegetation consists of Lodgepole pine and Douglas fir; Garlet very gravelly to stony loam is dominant soil and occurs on loamy steep mountain slopes between the ridges and drainageways unless interrupted by the presence of the Loberg soils on the lower portion of the landscape; Teton, Cheadle, and rock outcrop comprise 15% of unit; unit is from Gallatin Canyon survey by Olsen, et al,	8-50%
		Garlet (moderately deep variant)	Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
		Loberg	Typic Cryoboralfs	clayey-skeletal, mixed	>40" (20%)			
		Cheadle	Lithic Cryoborolls	loamy-skeletal, mixed	<20"			
		Teton	Typic Cryoborolls	fine-loamy, mixed				
207.	steep and very steep canyon walls with small pockets of debris accumulation and soil development	(t) Hauser	Lithic Argiborolls	loamy, mixed	<20"	U	wide climatic and vegetational range; unit dominated by presence of rock outcrop; Hazton has been dropped and correlated to Cheadle (Lithic Cryoborolls, loamy-skeletal, mixed) by the Montana SCS, but it is still listed in the most recent national key. Rock outcrop of 25-75%.	30-60+%
		Hazton (Wyo)	Lithic Cryoborolls	loamy, mixed	<20"			
			Lithic Ustic Torriorthents	loamy-skeletal, mixed (calcareous), frigid				
			Lithic Ustorthents	loamy-skeletal, mixed (calcareous), frigid	<20"			
			Borollic Lithic Haplargids	loamy, mixed	<20"			
			Aridic Lithic Argiborolls	loamy, mixed	<20"			
208.	nearly barren, very steep valley sides on sedimentary rocks	Cabbart	Ustic Torriorthents	loamy, mixed, frigid (calcareous), shallow	<20"		50-80% barren rock exposures of shales and limestones.	20-80%
		Yawdim (ND)	Ustic Torriorthents	clayey, montmorillonitic (calcareous), frigid, shallow	<20"			
		Yamac	Borollic Camborthids	fine-loamy, mixed	>40"			

EPD - Generalized Soil Mapping Unit Characteristics

Unit No.	Geomorphic Surface	Possible Included Soil Series	Subgroups	Families	Soil Depth & Compo-sition	Unit Type*	Descriptive Notes	Slope Range
209.	scree and talus slopes, rock out-crop at ridge crests		Lithic Cryorthents	loamy-skeletal, mixed (calcareous)	20"	U	rock outcrop dominants (60-90+%), but there are some deep soils in areas where regolith accumulation occurred; inclusion of Garlet (Typic Cryochrepts, loamy-skeletal, mixed, 40"); vegetation includes some alpine larch, Whitebark pine, and Krummholtz fir.	45-60%
		Merino	Lithic Cryorthents	loamy-skeletal, mixed (nonacid)	20"			
		Devore (Wash)	Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
210.	steep and very steep canyon walls with small pockets of debris accumulation and soil development		Lithic Cryorthents	loamy-skeletal, mixed	20"	U	found on Boulder batholith and pre-belt gneiss and schist; rock outcrop 25 to 75% of unit; forest climax.	30-60%
			Lithic Cryochrepts	loamy-skeletal, mixed	20"			
			Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
			Typic Cryochrepts	loamy-skeletal, mixed	40"			
211.	very steep mountainous lands		Lithic Cryorthents	loamy-skeletal, mixed (calcareous)	20"		vegetatively this unit is mostly barren but some scattered timber does occur. Rock outcrop of 20 to 55%.	45-60+%
			Typic Cryorthents	loamy-skeletal, mixed	20-40"			
			Typic Cryochrepts	loamy-skeletal, mixed	20-40"			
216.	made land (misc. land type)						the material in this unit is not considered to be a "soil", developed or otherwise; hence no soil taxonomy is appropriate.	

The use of out-of-state series names is to approximate for the otherwise non-existant series names for subgroups & families not yet recognised in Montana.

The interpretations are expressed in the form of comparative ratings where every mapping unit is individually evaluated using a rating schedule found in the unpublished Technical Appendix. Each mapping unit's rating fits into one of five categories, ranging from very poor to very good for road construction suitability, and from negligible to very high for erosion hazard. A map for each concern was prepared for the computer corridor selection process from the combined mapping units.

III. General Impacts

The disruption of the vegetative cover generally results in accelerated soil erosion. Roads, work sites, and staging areas increase the rate of erosion because of the lack of vegetative cover. Certain soil characteristics which make some soils inherently more erodible than others, combined with increasing slope and decreasing cover, will result in rill and gulley erosion, and, ultimately, in stream sedimentation. Where road cuts and road fills are constructed, the potential for mass movement is high, causing more soil to be exposed. Piping, or the subsurface lateral movement of soil particles by water, is common when a considerable amount of earth is piled up as a result of road cuts, and where earth is used for road fill across gullies. Piping is a significant source of stream sedimentation.

Certain mitigating measures can be used to minimize soil erosion from roads and work sites. In general, roads should be as direct as possible, but areas of higher slopes will require roads of greater length. In such cases, the appropriate water diversion practices should be used to keep soil movement to a minimum. Closed culverts should be used where road fill will impede any natural water flow, and open or closed culverts should be used on roads having higher slopes. Earth should not be moved onto sites near water flow. Unnecessary grading of level to fairly level ground with a blade should be avoided. It should be the aim of every crew foreman to expose as little soil as possible. Where soil is exposed, it should not be left vulnerable to erosion.

6.3.2.4. Vegetation

I. Introduction

The vegetative resources of the Clyde Park-Dillon study area, considered from economic and utilitarian standpoints, consist of three categories: rangeland, forest land, and altered land. Rangeland forms 46% of the study area; native grass and shrub communities are the basis of the livestock industry. Forests make up 36% of the study area and support not only the wood produce industry, but much of the area's recreational resources. Eighteen percent of the study area is altered, which means that native vegetational communities no longer exist where they once did. The altered land category contains much land which is highly valued by man, including agricultural land and urbanized areas.

The vegetation inventory is described in part II of this section. First, the classifications of vegetation used are explained and evaluated, and mapping procedures are reviewed. An analysis of vegetation types in the study area follows. The vegetation inventory consists of habitat types and community types which have been ranked with respect to potential forest and range productivity and rate of recovery. The map of the inventory, entitled "Vegetation Types," is contained in the pocket on the back cover. The charts that briefly explain the mapping units and show comparative ratings are found in Table 6-3 following the inventory description in part II.B. The combination of map and charts permits evaluation of each area in contrast to the others with respect to recovery and potential productivity.

In part III, the impacts of power transmission lines on vegetation, and the ranking of vegetation types with respect to these impacts, are explained. Proposed mitigating measures conclude this section. The unpublished Technical Appendix F contains a list of the common and generic names of all plant species noted in this section.

II. Inventory

Vegetation refers to groups of plants that have co-evolved in response to environmental factors. The basic unit of vegetation is the community, whereas the basic unit of flora is the species. Forest and rangeland contain natural plant communities and are amenable to consideration as vegetation, while cropland is best considered as a facet of land use.

The habitat type system of classification was chosen for this study. Habitat types are units of land identified by the climax[1] plant community (or association) they support; thus, the habitat type is actually a physical environment having a certain biotic potential. The habitat type system was chosen because it is well suited to mapping, equates areas by biotic potential, and, in the case of forests, can supply information on productivity, seral stages, regeneration problems, and special values.

Habitat types are well suited to impact assessment and resource allocation. The habitat type system was developed and modified by Daubenmire (1968, 1970). The two methods of classification used in this study were developed locally, though they share the basic philosophy of Daubenmire.

In habitat typing, certain plants are recognized to be more important indicators of specific environmental parameters than others, and reproductive success is given special consideration. The goal of classification is thus stated by Daubenmire (1968): "That system . . . closest to a natural one that allows the most predictions about a unit from the mere knowledge of its position in the system."

The hierarchal order in this system is series, habitat type, and sometimes phase. The series is identified from the overstory species that demonstrates the strongest tendency to perpetuate itself through time; for example, Douglas fir/ Understory indicator species (which usually have narrower environmental amplitudes and indicate special topoedaphic[2] factors or microclimate variation) identify the habitat type within a series; e.g., Douglas fir/pine grass habitat type. Sometimes a third indicator (phase) defines a yet finer unit within the habitat type; e.g., Douglas fir/pinegrass habitat type, bluebunch wheatgrass phase.

The fact that habitat types are named for climax association does not imply that climax communities are found everywhere or that climax communities are necessarily to be preferred in management. Rather, habitat typing allows recognition of inherently similar areas despite the camouflaging effects of disturbance.

The three properties that seem to best summarize the values of vegetation in a way that allows comparative assessment are potential range productivity, potential forest productivity, and recovery rate. The roles of vegetation in nutrient cycling and gas exchange, for example, cannot be differentially evaluated with existing knowledge.

II.A. Habitat Type Classifications, Procedures, and Evaluation

The classification of vegetation has a long history, which can be traced through the papers of de Candolle (1874), Cowles (1899), Warming (1909), Clements (1916), Ramensky (1926), Gleason (1926), Sukatchew (1928), DeRietz (1930), Braun-Blanquet (1932), Raunkiaer (1934), Tansley (1935), Cain (1947), Curtis (1959), Whittaker (1962), and Daubenmire (1966). The main problem of classifying vegetation and defining communities is essentially this: to set realistic criteria that divide the continuous variable of species coverage into units that can be treated as equivalent, while acknowledging that these units are not absolutely identical.

II.A.1. Habitat Type Classifications Used

II.A.1.a. Forest Habitat Types of Montana (Pfister et al. 1974)

Daubenmire's classification, which was developed largely in an area under maritime influence, cannot be successfully applied to all forest land in Montana because of the continental climate of parts of Montana and the resulting plant communities. Pfister et al. (1972, 1973, 1974) developed a Montana habitat type classification for forests using the same theory of plant associations as Daubenmire. Preliminary classifications were made in 1972 and 1973, and a final classification was completed in 1974. Nine series and 59 habitat types were identified.

Among the phenomena which can be correlated to forest habitat type are potential growth rate, susceptibility to certain pathogens, soil moisture regime, and mammalian ecology. In the current edition of Forest Habitat Types of Montana, information is provided on yield capabilities, site idexes, maximum tree heights, basal areas, climatic parameters, species distributions, relations of various habitat type classifications, and generalized geographic distribution of habitat types. Distributional parameters and special values and problems are also noted for each habitat type.

II.A.1.b. Mountain Grassland and Shrubland Habitat Types of Western Montana (Mueggler and Handl 1974)

Daubenmire (1970) also devised a classification for the steppe vegetation of Washington, which appears to have been a prototype for the Montana classification.

At the time of vegetation analysis for this study, a final edition of Mueggler and Handl's classification was not available, and the interim report (Mueggler and Handl 1974) was used. In the interim report, floristic information is provided in each habitat type description. Cover class summaries and a comparison of some differentially paired stands are provided. Soil moisture regime, slope, elevational range, and slope aspect are sometimes included, but management implications and productivity potentials have not yet been published for all types.

II.A.2. Habitat Typing and Mapping Procedure

II.A.2.a. Non-National Forest Lands

(i) Preliminary Delineations

Mapping was first done on aerial photographs with plastic overlays, and then transferred to cell maps. The majority of photos used were at a scale of 1:65,000 panchromatic, but some 1:20,000 scale panchromatic and 1:125,000 scale infrared photos were used.

Before field work, a number of obvious delineations were made on the aerial photo overlays. The forest-rangeland ecotone, riparian and agricultural areas, and areas altered to a degree which made habitat typing inapplicable were delineated.

(ii) Field Identification and Mapping

When possible, the aerial photographs were taken into the field for habitat type identification and delineation. On rangeland, this meant that areas judged to be not severely altered by grazing were located. The species coverage data required for use of the dichotomous keys was then recorded. The keys led to tentative identification of a habitat type, and the description of the habitat type was compared with the area in question. Usually, the description fit. If discrepancies were obvious, a comparison of other habitat type descriptions was made and judgement determined a "best fit."

After a representative stand was thus typed, ecotonal boundaries were delineated. This was done by moving away from the identified stand until an ecotone or change in association was perceived. The location of association change was marked on the overlay and the new association identified. This process was repeated in reference to the initial stand until enough points of association change were mapped to allow drawing a line delimiting the habitat type.

(iii) Transferral of Delineations

Aerial photo maps were transferred to cell maps using a Saltzman projector. The scale of these maps is ½" = 1 mile.

II.A.2.b. National Forest Lands

Seasonal and time constraints prevented on-the-ground habitat typing of national forest lands; therefore, a photo-interpretive approach was undertaken. This method will provide enough accuracy for the assessment of impacts and also for corridor selection. This is because habitat types in similar environments, subject to similar constraints, tend to have characteristics enabling them to be grouped for impact assessment, i.e., the factors that determine recovery rate and potential productivity are in some measure shared.

Forest Service data provided information for the Gallatin National Forest and the Beaverhead National Forest in the form of range and timber type maps. Ecological Land Unit information provided by the U.S. Forest Service was used where applicable.

Range maps and timber type maps were the main data source for both the Gallatin and the Beaverhead National Forest. Current habitat type information is being gathered on the Beaverhead National Forest by the U.S. Forest Service.

On the Deerlodge National Forest, timber type maps were used in combination with a 1935 range map.

II.A.2.c. Intermountain Forest and Range Experimental Station

Data gathered in the study area by Pfister et al. while developing their classification was used where applicable.

II.A.2.d. Other Data Sources

The vegetation maps of Patten (1963) and Dale (1973) provided data on timber types and dominant species.

When possible, field personnel sampled national forest land and recorded the data for later use when using aerial photographs.

Delineations of altered areas and areas having different dominant life forms, texture, slope, elevation, and aspect were made on aerial photos. Correlations between aspect and elevation and some habitat types, and the generalized distribution of habitat types in the Madison-Beartooth and Dillon-Lima areas (Pfister et al. 1974) were used in mapping.

II.A.3. Evaluation of Classification Used

II.A.3.a. Forest Habitat Types of Montana

An advantage of dichotomous keys is that everything ends up in some category, if only by default. After preliminary identification via the key, the description of the habitat type must be compared with what is found in nature to determine whether the classification is correct. To the credit of the authors of this system, field personnel found that use of the key and descriptions left little doubt regarding proper classification.

II.A.3.b. Mountain Grassland and Shrubland Habitat Types of Western Montana

The authors themselves identify the limitations of their system: "Conceivably, grazing would greatly increase the variation between stands which would otherwise be similar, which consequently would increase the uncertainty of breaking out probable habitat types. The foundation for classification, therefore, is somewhat tenuous . . ." Conversely, it is possible that grazing could increase the similarity between stands which would otherwise be dissimilar (Daubenmire 1970). Quoting again from the authors, "The key applies only to vegetation not severely altered from pristine. Consequently, successful identification of a habitat type depends upon considerable discernment by the user in judging successional status in making allowances for species appreciably altered by abusive grazing or other man-related treatments." Persons using this system in the field made maximum use of little-disturbed areas, and took grazing effects and population structure into account when using the key.

The preliminary classification (Mueggler and Handl 1974) is still being modified. Forage potential and management implications are currently under development and not yet available.

II.B. Analysis of Vegetation Types in the Study Area

In the following analysis, the numbers preceding the vegetative type(s) correspond to the numbers on the Vegetation Type map and in Table 6-3. The numbers in parentheses are the recovery rating for major (earthmoving) and minor (crushing, overstory removal) disturbances (see part III.A.2. for a discussion of recovery ratings).

II.B.1. Forest Habitat Types

1,2,3. Limber pine series (5,5). Hot and dry climate, steep slopes and poor soil development limit recovery in this series, often the first forest habitat types encountered adjacent to rangeland. Recovery may not be as slow as in subalpine habitat types, but is sufficiently slow to group them together when compared to other forest habitat types. Limber pine often shares dominance with mountain mahogany and Rocky Mountain juniper.

5,6. Douglas fir/heartleaf arnica; Douglas fir/Idaho fescue habitat types (4,4). These habitat types are warm and dry, but they are not considered as rugged as the limber pine series or the Douglas fir/bluebunch wheatgrass habitat type. They are often adjacent to each other and to fescue rangeland. Re-establishment of trees following overstory removal may be difficult even after scarification, although grasses are expected to do well following disturbance.

8,18. Douglas fir/ninebark; spruce/ninebark habitat types (3,3). These mesic habitat types usually have a luxuriant understory. Field observations of a power transmission line near Bozeman through the Douglas fir/ninebark habitat type indicate that rapid revegetation can be expected with a variety of grasses and shrubs. Ninebark was not observed in the disturbed area, but snowberry, white spirea, creeping Oregon grape, pinegrass, and a number of rangeland grasses were present. Aspen was an opportunist in this area, but apparently not elsewhere. The spruce/ninebark habitat type, distinguished by the presence of spruce, is quite similar to the Douglas fir/ninebark type.

11. Douglas fir/snowberry habitat type (3,3). This type is somewhat drier than the Douglas fir/ninebark habitat type, but recovery is expected to be similar. Only in the bluebunch wheatgrass phase is drought likely to limit recovery enough to justify a higher rating, but this phase was not commonly encountered.

12. Douglas fir/pinegrass habitat type (3,4). This mesic habitat type is expected to recover similarly to numbers 8 and 11 following major disturbance. A rating of 4 was given for response to minor disturbance because pinegrass often forms a dense sward in opening inhibiting conifer reproduction.

13. Douglas fir/elk sedge habitat type (4,4). This habitat type is similar to the Douglas fir/pinegrass habitat type, but it is drier and regeneration is more difficult, justifying a 4 rating in both categories.

15. Douglas fir/common juniper habitat type (4,4). This habitat type is found on dry limestone substrate, and is similar to and often adjacent to the Douglas fir/heartleaf arnica habitat type. Regeneration following overstory removal is expected to be fairly slow.

16. Douglas fir/bluebunch wheatgrass habitat type (5,5). This is the warmest and driest habitat type in the Douglas fir series. Limber pine may be present, slopes are steep, and soil may be unstable; regeneration problems can be expected. Recovery is deemed similar to that of the limber pine series.

20. Spruce/cleft-leaf groundsel habitat type (5,5). These sites will be very slow to recover, much like the limber pine/common juniper habitat type they sometimes abut. Unstable crushed limestone with little soil development, edaphic drought, and a sparse understory make these sites susceptible to both major and minor disturbance. Common juniper was the understory species with the highest coverage in this habitat type. Limber pine was well represented, but cleft-leaf groundsel was absent in the Ruby Mountains.

21,26. Spruce/twinflower; subalpine fir/twinflower habitat types (3,3). No special factors are expected to retard the recovery of these mesic habitat types.

22. Spruce/story Solomon's seal habitat type (3,3). This warm, mesic habitat type is found on benches and along streams. The presence of spruce testifies to a generous moisture supply. No special recovery problems are envisioned.

23. Subalpine fir/sweetscented bedstraw habitat type (3,3). This is the warmest of the wet-site subalpine fir habitat types in the study area. Recovery is expected to be very rapid, though high water tables may pose a construction problem.

24. Subalpine fir/dwarf huckleberry habitat type (3,3). This habitat type is usually found on frosty benches. Frost may be a limiting factor, but the indiginous species are well adapted and fairly rapid recovery is expected.

25. Subalpine fir/bluejoint reed grass habitat type (3,3). This very moist habitat type can be expected to recover rapidly, but high water tables may make construction difficult.

34. Subalpine fir/heartleaf arnica habitat type (4,4). This habitat type is often found adjacent to and higher than the Douglas fir/heartleaf arnica habitat type, suggesting a cooler and moister site, but field observations do not suggest that it will recover at a significantly more rapid rate in the study area. Understory coverage was often found to be scanty.

9,29. Subalpine fir/blue huckleberry; Douglas fir/blue huckleberry habitat types (3,3). Undergrowth is luxuriant in these cool, moist habitat types, and clearing will probably favor understory species, including huckleberry. No special problems are expected.

30. Subalpine fir/grouse whortleberry habitat type (4,3). The understory of this habitat type is expected to respond to overstory removal much like the understory of #29. Erosive soil and a more rigorous climate, however, suggest that recovery following major disturbance may be slower than in the other huckleberry habitat type.

31. Subalpine fir/pinegrass habitat type (3,4). This type is moister and cooler than the Douglas fir/pinegrass habitat type and recovery may be slightly more rapid, but essentially similar.

36. Subalpine fir-whitebark pine/grouse whortleberry habitat type (4,4). This habitat type contains considerable variation. Better sites are expected to recover fairly well, but drought, erosion, and regeneration problems may inhibit recovery on the poorer sites. Values of 4 were given because this type is considered less sensitive to disturbance than the timberline types it may abut.

38,39,40. Timberline habitat types (5,5). Timberline represents a harsh environment. Almost every conceivable climatic factor can be limiting, and, combined with poor soil development, accounts for the slowest recovery of all habitat types.

II.B.2. Rangeland Habitat Types

60,61. Needle and thread/blue grama, bluebunch wheatgrass/blue grama habitat types (2,1). These habitat types are often difficult to distinguish on average Montana rangeland. The greater than 5% coverage of blue grama indicates the warm, dry extreme of grassland habitat types. Semi-arid conditions are expected to retard recovery involving regeneration, but these habitat types appear to be quite resistant to crushing. Insufficient knowledge of grazing history makes segregation of the types sometimes questionable. There is also some question whether the areas in which blue grama is an important part of climax can now be mapped on the basis of present coverage and distribution because of the variable grazing response of blue grama (Wright et al. 1948, Ross et al. 1973).

62,63. Bluebunch wheatgrass/western wheatgrass; Bluebunch wheatgrass/ Sandberg's bluegrass habitat types (2,2). These habitat types are not expected to recover to a major disturbance as quickly as the moister Idaho fescue series. However, they may recover more quickly than the blue grama habitat types. Recovery to crushing is expected to be similar to the fescue series, and slower than the two habitat types with blue grama.

66,67,71. Idaho fescue series (1,2). The Idaho fescue series was rated faster in recovery to a major disturbance than the bluebunch wheatgrass series, based upon a consideration of moisture, and, to a lesser degree, temperature. It is not expected to be as resilient to crushing as the blue grama types, partly because of topographic differences.

74. Dwarf sagebrush/bluebunch wheatgrass habitat type (2,1). This droughty and sometimes rocky habitat type is expected to recover much as the dry grassland habitat types containing blue grama, although the droughty condition may be more soil-caused.

76,78. Big sagebrush series (2,2). This habitat type is often found on scree, talus, creeping soil, and alluvial outwashes. Recovery rate may be similar to that of bluebunch wheatgrass habitat types. Scarification may favor re-establishment of big sagebrush.

Big sagebrush can greatly increase in areas where it is not a dominant part of the climax community (Ross 1973, Wright et al. 1948), and it can be exceedingly difficult to determine whether it is part of the climax community in an area just by simple observation. There may be enough genetic variation within this species to account for more than one habitat type (Morris, personal communication). The presence of big sagebrush seed in areas where it is not a climax dominant can often be explained by rodent activity or zootic disclimaxes.

The big sagebrush series was conservatively identified. When it formed a mosaic with grassland, grassland was mapped.

86. Mountain mahogany/bluebunch wheatgrass habitat type (5,3). This habitat type is associated with steep and often southern exposures. Soil development is poor to non-existent on usually calcareous substrates, and grass cover is often scanty. The response to major disturbance is expected

to be similar to the limber pine series. On poor sites, road cuts may require massive excavation resulting in unmodified rock substrate. On better sites, limber pine, Rocky Mountain juniper, skunkbrush sumac, and big sagebrush may be associates.

87,88. Skunkbush sumac series (4,3). In the Dillon area, this habitat type was not associated with a particularly rugged site, but in the central portion of the study area, it was associated with the mountain mahogany/ bluebunch wheatgrass habitat type, except that a more rapid recovery from a major disturbance is expected.

89,90. Greasewood series (3,3). These are saline lowland habitat types. Topography and nearness to water result in excessive livestock use of these areas, making it difficult to judge natural condition and recoverability. Near-pristine stands suggest a slower recovery after a major disturbance than bluebunch wheatgrass grassland. Crushing may often kill greasewood, and thus a rating of 3 was given.

II.B.3. Community Types Identified by Pfister et al. (1974)

43. Lodgepole pine/dwarf huckleberry (3,3). This community type is very similar to the subalpine fir/dwarf huckleberry habitat type, and a similar recovery rate is expected.

46. Lodgepole pine/pinegrass community type (3,4). This habitat type is similar to the Douglas fir/pinegrass and subalpine fir/pinegrass habitat types, and has been given the same ratings.

II.B.4. Community Types Not Found In The Classifications Used

47,48.49. Poplar series (3,3). These types are mesic to hydric and are expected to recover as rapidly as any forest habitat type. Coppice regeneration can be expected following overstory removal by cutting. Consideration should be given to seasonal disturbance due to spring runoff in these areas.

50. Rocky Mountain juniper/bluebunch wheatgrass community type (3,3). Rocky Mountain juniper may be a member of other habitat types, especially those in the limber pine and mountain mahogany series. This community type was mapped when coverage of other indicator species was very low. These sites are not as rigorous as limber pine and mountain mahogany sites, and are expected to recover more rapidly than sagebrush habitat types.

91. Inland saltgrass/western wheatgrass community type (2,1). These hydric and often saline areas are expected to recover quickly, as no special factor appears limiting.

92. Mountain mahogany/Idaho fescue community type (3,3). This type was found only north of Blacktail Creek. The site was less rugged than mountain mahogany/bluebunch wheatgrass sites and parent material was probably not calcareous. This type is differentiated from the mountain mahogany/bluebunch wheatgrass habitat type of having greater than 5% coverage of Idaho fescue. Recovery is expected to be similar to the Rocky Mountain juniper/bluebunch wheatgrass community type.

TABLE 6-3

EPD - VEGETATION TYPE CHARACTERISTICS

Unit No.	Habitat or Community Type	Dominant Species Present		Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
					Forest	Range			Major	Minor
1	limber pine/ bluebunch wheatgrass	limber pine Rocky Mountain juniper	big sagebrush bluebunch wheatgrass needle & thread	bluebunch wheatgrass needle & thread indian ricegrass	2	2	5000-6500	SW	5	5
2	limber pine/ Idaho fescue	limber pine Rocky Mountain juniper	big sagebrush bluebunch wheatgrass Idaho fescue	bluebunch wheatgrass Idaho fescue needle & thread indian ricegrass	2	3	6000-8000	SW	5	5
3	limber pine/ ~~common~~ juniper	limber pine common juniper heartleaf arnica one-sided wintergreen	harebell rock clematis russet buffaloberry	Douglas fir	2	1	6500-8000	NR*	5	5
5	Douglas fir/ heartleaf arnica	limber pine Douglas fir common juniper	heartleaf arnica Idaho fescue strawberry	Douglas fir Idaho fescue	3	1	6700-8000	NR	4	4
6	Douglas fir/ Idaho fescue	Douglas fir bluebunch wheatgrass	Idaho fescue big sagebrush	Douglas fir bluebunch wheatgrass Idaho fescue	3	3	6200-7300	NR	4	4

* Nonrestricted

EPD - Vegetation Type Characteristics

Unit No.	Habitat or Community Type	Dominant Species Present		Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
					Forest	Range			Major	Minor
8	Douglas fir/ ninebark	Douglas fir snowberry	ninebark pinegrass	Douglas fir	4	3	5800-6800	N	3	3
9	Douglas fir/ blue huckleberry	lodgepole pine Douglas fir one-sided wintergreen woods pussy-toes	creeping Oregon grape blue huckleberry sweet-cicely white spirea	lodgepole pine Douglas fir blue huckleberry	4	3	5500-7500	S	3	3
11	Douglas fir/ snowberry	Douglas fir heartleaf arnica serviceberry	snowberry white spirea pinegrass	Douglas fir Idaho fescue pinegrass	4	3	5000-7200	SE	3	3
12	Douglas fir/ pinegrass	Douglas fir lodgepole pine heartleaf arnica	pinegrass elk sedge bearberry	Douglas fir lodgepole pine Idaho fescue bluebunch wheatgrass	4	3	6000-7600	NE	3	4
13	Douglas fir/ elk sedge	common juniper Douglas fir creeping Oregon grape	elk sedge heartleaf arnica western meadowrue	Douglas fir	4	3	6100-7600	SW	4	4
15	Douglas fir/ common juniper	lodgepole pine Douglas fir common juniper	heartleaf arnica white spirea creeping Oregon grape	Douglas fir lodgepole pine	4	1	6000-7500	N	4	4

EPD - Vegetation Type Characteristics

Unit No.	Habitat or Community Type	Dominant Species Present		Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
					Forest	Range			Major	Minor
16	Douglas fir/ bluebunch wheatgrass	limber pine Douglas fir big sagebrush	bluebunch wheatgrass needle and thread arrowleaf balsamroot	Douglas fir bluebunch wheatgrass needle and thread indian ricegrass	2	3	5800-6800	NR	5	5
18.	spruce/ninebark	Douglas fir spruce snowberry	white spirea elk sedge ninebark	Douglas fir spruce lodgepole pine	5	3	6000-7000	N	3	3
20	spruce/cleft-leaf groundsel	limber pine Douglas fir	common juniper one-sided wintergreen	spruce Douglas fir	3	1	7500-8600	SE	5	5
21	spruce/twinflower	spruce lodgepole pine Douglas fir	blue huckleberry pinegrass twinflower grouse whortleberry	lodgepole pine Douglas fir spruce	5	2	6600-7200	NE	3	3
22	spruce/starry solomon's seal	spruce Douglas fir pinegrass	snowberry starry Solomon's seal fairy bells	Douglas fir spruce	5	3	5000-7000	NR	3	3
23	subalpine fir/ sweetscented bed--straw	subalpine fir spruce Douglas fir	sweetscented bedstraw twisted stalk baneberry	Douglas fir spruce lodgepole	5	3	6000-7200	NR	3	3
24	subalpine fir/ dwarf huckleberry	subalpine fir lodgepole pine dwarf huckleberry	twinflower grouse whortleberry pinegrass	lodgepole	5	2	6000-7200	NR	3	3

EPD - Vegetation Type Characteristics

Unit No.	Habitat or Community Type	Dominant Species Present		Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
					Forest	Range			Major	Minor
25.	subalpine fir/ bluejoint reedgrass	spruce subalpine fir lodgepole	trapper's tea bluejoint reedgrass arrowleaf groundsel	spruce lodgepole pine	5	3	7000- 8500	NR	3	3
26.	subalpine fir/ twinflower	Douglas fir lodgepole pine spruce subalpine fir	pinegrass mountain arnica twinflower	lodgepole pine Douglas fir	5	2	6000- 7200	N	3	3
29	subalpine fir/ blue huckleberry	lodgepole pine Douglas fir spruce	blue huckleberry grouse whortleberry pinegrass heartleaf arnica	lodgepole pine Douglas fir spruce blue huckleberry	5	2	7000- 8100	NR	3	3
30	subalpine fir/ grouse whortleberry	lodgepole pine spruce subalpine fir	mountain arnica pinegrass elk sedge grouse whortleberry	lodgepole pine Douglas fir	4	2	6800- 8800	NR	4	3
31	subalpine fir/ pinegrass	lodgepole pine Douglas fir subalpine fir spruce	heartleaf arnica pinegrass elk sedge western meadowrue	lodgepole pine Douglas fir	5	3	7200- 7700	NR	3	4
34	subalpine fir/ heartleaf arnica	Douglas fir lodgepole pine spruce subalpine fir	heartleaf arnica one-sided wintergreen sweet-cicely western meadowrue	Douglas fir lodgepole pine Idaho fescue spruce	5	1	7600- 8400	NR	4	4

EPD - Vegetation Type Characteristics

Unit No.	Habitat or Community Type	Dominant Species Present		Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
					Forest	Range			Major	Minor
36	subalpine fir-whitebark pine/grouse whortleberry	spruce subalpine fir whitebark pine lodgepole	elk sedge grouse whortleberry mountain arnica arnica hawkweed	subalpine fir spruce Idaho fescue	3	2	8000-9000	NR	4	4
38	whitebark pine-subalpine fir	spruce whitebark pine subalpine fir	grouse whortleberry mountain arnica alpine hawkweed	none	2	1	8500-9800	NR	5	5
39	alpine larch-subalpine fir	alpine larch subalpine fir spruce whitebark pine	grouse whortleberry mountain-heath	none	2	2	8500-10000	NR	5	5
40	whitebark pine	whitebark pine common juniper	Idaho fescue elk sedge sweet cicely	Idaho fescue	2	2	8500-10000	NR	5	5
60	needle and thread blue grama	needle and thread blue grama	narrow-leaved sedge fringed sagewort	needle and thread narrow-leaved sedge	1	3	4000-6600	NR	2	1
61	bluebunch wheatgrass/blue grama	needle and thread narrow-leaved sedge Sandberg's bluegrass blue grama	fringed sagewort bluebunch wheatgrass prairie junegrass prickley-pear cactus	needle and thread bluebunch wheatgrass	1	4	4300-6000	NR	2	1

EPD - Vegetation Type Characteristics

Unit No.	Habitat or Community Type	Dominant Species Present		Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
					Forest	Range			Major	Minor
62	bluebunch wheatgrass/ western wheatgrass- thickspike wheatgrass	needle and thread Sandberg's bluegrass prairie junegrass broom snakeweed thickspike wheatgrass	big sagebrush western wheatgrass fringed sagewort bluebunch wheatgrass	bluebunch wheatgrass threadleaf sedge western wheatgrass	1	4	4200-5800	NR	2	2
63	bluebunch wheatgrass/ Sandberg's bluegrass	needle and thread prairie junegrass broom snakeweed green rabbitbrush	Sandberg's bluegrass big sagebrush bluebunch wheatgrass	bluebunch wheatgrass needle and thread	1	4	5000-6400	NR	2	2
66	Idaho fescue/ western wheatgrass- thickspike wheatgrass	Idaho fescue prairie junegrass thickspike wheatgrass Hood's phlox	western wheatgrass big sagebrush cusick bluegrass	bluebunch wheatgrass western wheatgrass Idaho fescue	1	5	4700-8000	NR	1	2
67	Idaho fescue/ bluebunch wheatgrass	big sagebrush prairie junegrass narrow-leaved sedge bluebunch wheatgrass	Idaho fescue Sandberg's bluegrass fringed sagewort	bluebunch wheatgrass	1	5	4600-9000	NR	1	2
71	Idaho fescue/ tufted hairgrass	Idaho fescue cinquefoil sedge sp. Ross avens	tufted hairgrass lupine sp. clover	Idaho fescue tufted hairgrass	1	5	7700-10000	NR	1	2

EPD - Vegetation Type Characteristics

Unit No.	Habitat or Community Type	Dominant Species Present		Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
					Forest	Range			Major	Minor
74	dwarf sagebrush/ bluebunch wheatgrass	bluebunch wheatgrass Sandberg's bluegrass dwarf sagebrush	prairie junegrass big sagebrush Hood's phlox	bluebunch wheatgrass needle and thread	1	3	4500-7000	NR	2	1
76	big sagebrush/ bluebunch wheatgrass	big sagebrush fringed sagewort prairie junegrass Sandberg's bluegrass	needle and thread broom snakeweed bluebunch wheatgrass	bluebunch wheatgrass needle and thread	1	3	5000-7000	NR	2	2
78	big sagebrush/ Idaho fescue	big sagebrush Idaho fescue cinquefoil pussy-toes	prairie junegrass geranium bluebunch wheatgrass prairie smoke	bluebunch wheatgrass Idaho fescue	1	4	6000-7500	NR	2	2
86	mountain mahogany/ bluebunch wheatgrass	big sagebrush skunkbush sumac indian ricegrass	mountain mahogany bluebunch wheatgrass Rocky Mountain juniper	bluebunch wheatgrass indian ricegrass	1	2	5200-6600	NR	5	3
87	skunkbush sumac/ bluebunch wheatgrass	needle and thread big sagebrush bluebunch wheatgrass vetch	skunkbush sumac prickly-pear cactus fringed sagewort	bluebunch wheatgrass needle and thread	1	2	4800-5600	NR	4	3

EPD - Vegetation Type Characteristics

Unit No.	Habitat or Community Type	Dominant Species Present	Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
				Forest	Range			Major	Minor
88	skunkbush sumac/ Idaho fescue	needle and thread big sagebrush bluebunch wheatgrass skunkbush sumac Idaho fescue yarrow	bluebunch wheatgrass Idaho fescue needle and thread	1	2	5600-6500	NR	4	3
89	greasewood/ western wheatgrass	big sagebrush western wheatgrass alkali bluegrass greasewood saltbush	greasewood western wheatgrass	1	3	4000-5700	NR	3	3
90	greasewood/ basin wildrye	western wheatgrass greasewood prickley-pear cactus prairie junegrass basin wildrye	greasewood western wheatgrass basin wildrye	1	4	4000-5700	NR	3	3

EPD - Vegetation Type Characteristics

Unit No.	Habitat or Community Type	Dominant Species Present		Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
					Forest	Range			Major	Minor
	Community Types									
43	lodgepole pine dwarf huckleberry	lodgepole pine dwarf huckleberry bearberry	pinegrass grouse whortleberry	lodgepole pine	5	2	5500-7000	NR	3	3
46	lodgepole pine/ pinegrass	lodgepole pine whitebark pine bearberry	pinegrass heartleaf arnica white spirea	lodgepole pine	4	3	6700-7500	NR	3	4
47	cottonwood-willow	cottonwood willow	rose sp. sedge sp. Missouri gooseberry	basin wildrye	5	3	4000-6000	NR	3	3
48	aspen/alder/willow	alder sp. willow aspen	Missouri gooseberry Arkansas rose Rocky Mountain flag basin wildrye	aspen alder	5	3	5000-7000	NR	3	3
49	aspen/Douglas fir	aspen Douglas fir Missouri gooseberry Rocky Mountain flag	Arkansas rose ninebark creeping Oregon grape sedge sp.	Douglas fir aspen	5	2	5000-7000	NR	3	3

EPD - Vegetation Type Characteristics

Unit No.	Habitat or Community Type	Dominant Species Present		Species of Prime Economic Importance	Productivity Capacity		Elev	Aspect	Recovery Rate from disturbance	
					Forest	Range			Major	Minor
50	Rocky Mountain juniper bluebunch wheatgrass	Rocky Mountain juniper limber pine	big sagebrush bluebunch wheatgrass indian ricegrass	bluebunch wheatgrass indian ricegrass	1	2	4500-6500	W	3	3
91	inland saltgrass/ western wheatgrass	western wheatgrass inland saltgrass	foxtail barley squirreltail foxtail	western wheatgrass	1	4	4500-5000	NR	2	1
92	mountain mahogany/ Idaho fescue	big sagebrush bluebunch wheatgrass	Idaho fescue mountain mahogany indian ricegrass	Idaho fescue bluebunch wheatgrass	1	3	6500-7500	N	3	3

III. Impacts and Mitigating Measures

The impacts of a power transmission line on vegetation can be categorized according to how they might influence corridor selection. Using this criterion, there are three conceptual types of transmission line impacts on vegetation: those that can be used to determine route at the habitat type level, those that can be used to determine route at a broader level, and those that cannot be used to determine route. For example, road construction usually necessitates vegetation removal and soil displacement. Severe vegetative impacts can be expected from this process; therefore, road impacts should be considered at the habitat type level when evaluating transmission line routes. Other impacts are secondary and affect corridor placement in a more general manner. For example, bark beetle epidemics emanating from improper slash disposal might occur in a broadly restrictive area, i.e., in forests only. Still other impacts cannot be evaluated differentially. Ozone production may detrimentally affect vegetation, but there is no information available to predict effects of ozone on various vegetative associations. This means that a comparative approach to route selection cannot incorporate the differential response of vegetation to ozone, even if ozone is harmful to vegetation. Therefore, consideration of ozone effect might rightfully influence the decision whether a line ought to be built, but it cannot be used to determine where it should be built.

III.A. Route-Determinant Impacts

The most significant and assured impacts of transmission lines on vegetation come from road and tower construction, and road maintenance. The complete but localized destruction of vegetation from such earth-moving activities is considered "major" when evaluating recovery rate. For instance, in a logging operation without roads, sediment was 60% greater than in an unlogged control drainage. A logged area with roads had extensive erosion and soil movement, with 7500% more sediment than in the same control drainage (Magahara and Kidd 1972). An example of a "minor" impact is crushing or overstory removal without roads.

Potential productivity and recovery rate are the parameters of vegetational impact assessment used as inputs for corridor selection. The habitat and community types of the study area are rated relative to one another on these dual criteria in Table 6-3. The techniques used to arrive at these ratings are explained on the following pages, while the specific factors affecting each recovery rating are noted in the inventory section, part II.A.

III.A.1. Productivity

Productivity refers to the amount of biomass produced in a given area during a given amount of time. Potential productivity was used as a parameter rather than existing productivity for two reasons. First, because power transmission lines require long-term commitment of land, existing productivity could result in short-sighted impact allocation. Secondly, existing productivity cannot be accurately predicted by habitat typing because of variable history and stand development. However, it is expected that comparative productivity rankings, whether potential or existent, would be the same, although the values for potential and existent productivity would differ.

A high impact rating corresponds to a highly productive habitat type; that is, taking highly productive land out of production has a higher impact than the loss of less productive land.

III.A.1.a. Forest Productivity

Quantitative data were available for rating the forest habitat types relative to each other. Pfister et al. (1974) listed the ranges of potential productivity of the various east-side forest habitat types in cubic feet of wood per acre/year. Using this data, five productivity categories were established. These were: category one, 0-30 cubic feet per year; category two, 30-50 cubic feet per year; category three, 50-70 cubic feet per year; category four, 70-90 cubic feet per year; and category five, over 90 cubic feet per year. The median of the yield capability range determines into which category each habitat type fell. None of the medians fell into the highest category. The forest habitat types ratings ranged from two to five, whereas all rangeland habitat types were rated as ones.

The potential range productivity of the forest habitat types was based on the Constancy and Average Coverage table of Pfister et al. (1974). For each habitat type, the grass coverage was summed for those species whose constancy value was five or greater (present in over 45% of the stands sampled). The resulting figures were divided into three categories of nearly equal size.

In calculating the range potential of forests, it is assumed that forest will be forests, and not managed as rangeland. To do otherwise would invalidate the forest productivity ratings, since a site cannot be managed to simultaneously maximize both timber and grass production. Three categories were used rather than five because field personnel judged that the most productive forest habitat types are equivalent to the least productive grassland habitat types with respect to potential range productivity. Thus, forest habitat types were rated as ones, two, or threes in the range category, while grassland habitat types were rated as threes, fours, or fives.

III.A.1.b. Range Productivity

Potential productivity of the shrubland and grassland habitat types is not quantified in any single source, and so a selection of various systems was used. Mueggler and Handl (1974) did not determine productive capacity in their interim report. The Soil Conservation Service rates carrying capacity on the basis of range site and condition, and does not apply to habitat types. Payne (1974) has published a paper correlating ground cover with weight for a number of range species, but this data was not sufficient to calculate habitat type productivity using the constancy and average coverage data of Mueggler and Handl (1974).

Davis (1975) compiled a guide for determining potential productivity on certain grassland and shrubland habitat types selected to span the range of productivity values. The productivity values assigned by Davis to the various habitat types have been incorporated into the rating system used in this study. The ratings are also based upon field observation of the moisture availability, elevation, slope, and aspect associated with each habitat type. Of these associated factors, moisture was accorded the most significance, as is suggested by Ellison (1960). Grassland rating went from three to five to complement the range ratings of the forest habitat types.

Potential productivity data on shrubland habitat types was also in short supply. The work of Davis (1975) was used when possible to rate these habitat types in conjunction with field observations. Again, moisture was given highest consideration when data did not exist. Ratings for shrublands fell within the ratings of grassland habitat types and the forest habitat types.

III.A.2. Recovery Rate

Recovery is a multifaceted concept, the various aspects of which are tied together by the goal of revegetation and establishment of stable plant communities. Recovery can be defined in terms of aesthetics, erosion stablilization, or productivity and energy budgets.

In general, relative recovery relationships will remain the same no matter how recovery is defined. That is, the amount of time it takes to achieve the "recovered" level in one habitat type relative to another habitat type will remain essentially the same. However, in order to assign ratings, three criteria were used to provide a more concrete definition:

1) Life-form. An area is not considered recovered unless indigenous late-successional life-forms dominate.

2) Erosion Prevention. Soil development partially determines which plants can grow and prosper in an area. Soil evolution is a very slow process, often measured in hundreds and thousands of years. In order for an area to recover, its soil must be kept intact. For this reason, prompt revegetation with plants that prevent accelerated erosion is a necessary part of recovery. The naturally occurring late-successional and climax plant communities provide maximum erosion protection.

3) Productivity and Economic Properties. Recovery includes establishing plant communities with productive and economic properties similar to those of pre-disturbance communities. Areas where recovery proceeds slowly due to limiting factors are more severely impacted by construction activities than sites that recover more quickly. A high rating refers to a high impact and slow recovery rate.

III.A.2.a. Recovery of Forests

Forest habitat types as a group were rated slower in recovery than grassland habitat types, for, in a sense, forest habitat types never recover as long as the power transmission line exists. This rating is justified in terms of the preceding definition of recovery:

1. Life-form: the dominant late successional life form (trees) is not allowed to dominate.
2. Erosion Prevention: forests are generally most effective in reducing erosion (Golley 1972), and forests are not usually allowed in utility corridors.
3. Productivity and Economic Properties: when forest habitat types are managed to favor understory species, a negative long-term impact on the timber industry can be expected. Ranchers may benefit in the short run, depending upon the palatability of the species occupying the site and accessibility to livestock. Productivity may be lower on forest habitat types when trees are excluded.

The forest habitat types were rated relative to one another on the basis of field observations of limiting factors and the descriptions of Pfister et al. (1974). These ratings were reviewed and adjusted with Pfister and Arno.

III.A.2.b. Recovery of Rangeland

Two principal factors limit the rate of recovery in grasslands and shrublands: available moisture and grazing (Dyksterhuis 1951). Grazing pressure is the prerogative of the land owner, hence it is unpredictable and cannot enter any calculations. Moisture, then, is the primary analyzable determinant of recovery rate. Moisture is also the main limiting factor for productivity, so alignment of grassland habitat types along a moisture gradient similar to the one used in determining potential productivity was used in rating grassland recovery rate.

Power transmission lines allow all three criteria of recovery to be met, and so no overlaps of recovery rate with forest habitat types was allowed. This leaves two categories for grasslands. Our experience indicates that blue grama is present only on the warmest and driest sites, so the two habitat types containing appreciable amounts of blue grama were rated as two with respect to recovery and all other grassland habitat types were rated as ones (fastest recovery). Subalpine grasslands would have been rated as very slow to recover if they had been mapped, but weather and time constraints prevented positive identification of such habitat types.

Shrubland habitat types may recover as rapidly as grasslands or as slowly as some forest habitat types. Few generalizations can be made about them, and the specific factors which determine shrubland habitat type recovery rates have been explained for each vegetation type in section II.B.

III.B. Other Impacts

The most significant and assured impacts associated with the proposed transmission line have been used by field personnel to determine and evaluate corridor selection. The following impacts on vegetation have been investigated.

III.B.1. Air Pollutants

Oxidants produced by corona discharge are generally considered to be the major air pollutants associated with power transmission lines. Of these oxidants, ozone (O_3) is the most likely to occur in measurable quantities. The impacts of ozone from transmission lines have been reviewed by Goodland (1973) and Kitchings et al. (1974).

There is no question that ozone is detrimental to plants; the question is whether we can say with any assurance that the ozone from the proposed 161-kV line would harm plants.

Frydman et al. (1972) and Fern and Brabets (1974) conducted field studies associated with 765-kV lines and were unable to detect any measurable amount of ozone. Roach et al. (1973) and Scherer et al. (1972) conducted laboratory studies to determine ozone production under a variety of environmental conditions and determined that ground level concentration of ozone produced by high voltage (greater than 500 kV) transmission lines would probably be insignificant. Goodland (1973) shares the opinion that ozone impact is negligible, except in already polluted areas.

The effect on plants of ozone from a 161-kV line is not considered significant enough to warrant its inclusion among the factors that will determine the decision whether to construct the proposed line.

III.B.2. Electrostatic and Magnetic Fields

Electro-magnetic force fields (measured in volts/meter) of the industrial range (50 hertz) are found near electrical transmission lines. In the case of high voltage lines (400-500 kV), the area near the lines may have an electrical field of several thousand V/m (Pressman 1970). Murr (1965 a,b; 1966) found no apparent effect on corn, beans, and sorghum growth until a field of 100 kV/m dynamic potential gradient of direct current was reached. This is far in excess of the fields near transmission lines, though such fields may be reached during lightening storms (Murr 1966).

The effects of lower level magnetic fields have been studied and reviewed (Audus 1960, Scott 1962, Barnothy 1969, Marha et al. 1971). Zurbitskty (1972) found that plants exposed to a 180 V/m force field grew faster than control plants. Gardner et al. (no date) studied the effects of low (10 V/m) electric fields on plants and soil microorganisms. These results also indicated that growth may increase in an electrical field.

At present, there is no reason to suggest that the impact of electrostatic fields caused by transmission lines is significant with respect to vegetation.

III.B.3. Logging Debris

The merchantable timber felled for right-of-way clearing should be marketed. Logging practices leave the unmerchantable parts of the tree (called slash) on the ground. This can result in fuel build-up and/or a Dendroctonus bark beetle or Ips slash beetle outbreak. Logging slash is also unattractive and can impede human, livestock, and wildlife travel.

There are a number of ways to dispose of logging slash, and the choice of the proper method must be made area by area. Slash can be chipped, buried, or burned in special burners, but all of these require the concentration of slash at roads. These techniques minimize air pollution, but are energy intensive and disrupt nutrient cycling. In some cases, the energy necessary to concentrate slash and the additional disruption it causes may outweigh the benefits. Broadcast burning or piling and burning are recommended when they are believed to cause the least impact. In any case, slash disposal should take place within three years, and often sooner, depending on fuel conditions.

III.C. Mitigating Measures

III.C.1. Route-Determinant Activities

The following mitigating measures minimize the impact of route-determining activities and foster economy in construction.

The total length of access roads and road width should be kept to the minimum required for construction equipment. Single-lane roads with turnouts are preferable; existing roads should be used when available. Since the total length of roads and width of disturbance per linear mile of transmission line increase with slope, given a constant road grade, steep areas should be avoided.

Prompt revegetation with selected species is in all cases desirable for the following reasons:

1. Erosion Control. Without the stabilizing presence of vegetation, accelerated erosion results in site quality deterioration and problems in future revegetation.

2. Noxious Plant Control. Secondary succession may begin with opportunistic species that land owners may consider "noxious."

   In the past, blanket herbicide spraying programs have been a part of right-of-way maintenance. Such programs are expensive and inherently anti-ecological.

Weed growth can best be prevented by establishment of stable plant communities.

3. Conifer Control. Scarified areas favor conifer establishment, thus these areas should be kept to a minimum. Since large trees are usually not considered compatible with power transmission lines, and if tree regeneration is undesirable, rapid establishment of heavy grass, forb, and shrub coverage should be favored.

   However, if should be expected that some trees will establish themselves in a transmission line clearing despite efforts to the contrary. Manual removal of these trees is favored; management of the transmission line right-of-way as a Christmas tree farm or encouragement of Christmas tree seekers provides economical means of tree removal.

4. Economic Value. Productivity and economic value can be enhanced, in some cases, by purposeful revegetation. These objectives can be accomplished by hydroseeding, whereby a slurry of water, seed, and mulching agent is shot from the nozzle of a truck-mounted apparatus. Mulch of straw or wood chips provides insulation, inhibits erosion, and favors microorganism activity (Ludeke, no date). The advantages of hydroseeding in establishing ground cover may be considerable (U.S.D.S. 1970). In addition to hydroseeding, all roads and skid trails of over 10% grade should have erosion barriers. Hydroseeding is expected to speed recovery, but vegetation cannot be expected to provide erosion control and prevent soil slippage on unstable slopes (SCS 1971).

The grass species listed in Table 6-4 are suitable for seeding and are commercially available. A mixture of at least five of these species should be hydroseeded with mulch in the appropriate elevational ranges at the specified rate.

Except in the driest grassland and shrubland habitat types, where moisture is the primary limiting factor, fertilization would probably increase recovery rate. However, fertilizing rangeland may be a questionable allocation of a relatively scarce resource; furthermore, fertilization might favor opportunistic species and thus neutralize any positive effects.

It should be realized that seed and mulch cannot stimulate revegetation of an area without time and protection to recover. On federally-owned lands, grazing should be deferred for a minimum of three years (The Interagency Forage, Conservation, and Wildlife Handbook 1973). Roads should be closed except in uncommon extenuating circumstances.

Roads are infrequently used for power line maintenance; often power lines are upgraded before any given road system is used for repair. It is

TABLE 6-4

Elev	Generic Name	Common Name	Pounds Seed Per Acre[1]
<6000'	*Agropyron cristatum*	crested wheatgrass	12.4
	Agropyron dasytachyum	thickspike wheatgrass	13.4
	Agropyron inerme	beardless wheatgrass	10.9
	Agropyron riparium	streambank wheatgrass	11.2
	Agropyron smithii	western wheatgrass	18.8
	Elymus juncens	Russian wildrye	15.6
	Festuca ovina var. duriscula	sheep fescue	12.4
	Stipa viridula	green needlegrass	52.2
6000-8000	*Agropyron intermedium*	intermediate wheatgrass	17.3
	Agropyron trachycaulum	slender wheatgrass	14.9
	Bromus inermis	smooth brome	12.9
	Bromus marginatus	California brome	12.1
	Dactylis glomerata	orchardgrass	8.4
	Festuca ovina var. duriscula	sheep fescue	12.4
	Festuca scabrella	rough fescue	12.2
	Poa pratensis	Kentucky bluegrass	11.2
>8000'	*Agropyron trachycaulum*	slender wheatgrass	14.9
	Alopercurus arundinaceus	tall foxtail	11.2
	Alopercurus pratensis	meadow foxtail	11.2
	Bromus inermis	smooth brome	12.9
	Bromus marginatus	California brome	12.1
	Festuca scabrella	rough fescue	12.2
	Phleum pratense	common timothy	6.8
	Poa pratensis	Kentucky bluegrass	8.9

[1] Divided by number of species

Note: Seeding rates are from the Interagency Forage, Conservation, and Wildlife Handbook, 1973. Rates are doubled for broadcast seeding (SCS 1967). Figures have been adjusted for average purity and germination.

better from vegetative and economic standpoints, therefore, to reopen a road if necessary than to keep it in a constant state of readiness. All-terrain vehicles or even steel-track tractors should be used for maintenance in rugged areas rather than keeping roads open. The occasional crushing caused by these vehicles is less harmful to vegetation than maintenance for conventional vehicular access.

Specific mitigating measures concerning clearings, road construction, tower erection, conductor stringing, and clean-up are included in the following section of this report.

III.C.2. Construction

III.C.2.a. Clearing

1. Clear the minimum width necessary.
2. Comply with the Environmental Criteria for Electric Transmission Systems issued by the U.S. Department of Interior.
3. Combine special sites such as reel sites, staging areas, and roadways whenever possible.
4. Sell all merchantable timber, and dispose of slash in the most environmentally compatible way, be it broadcast burning, burning of piled slash, burning in special burners, chipping, or burying.
5. Minimize cross-country equipment travel, except when the alternative is more environmentally disruptive.
6. The minimization of clearings should be a component of the planning process.
7. Use the least disruptive clearing technique practical.
8. Cut stumps to within 12" of the highest ground.
9. Disturb low growing vegetation as little as possible.
10. Stockpile and redistribute topsoil at staging areas and tower pads.
11. Screen the cleared area from visual vantage points when this does not accentuate other types of environmental disruption.
12. Avoid talus, scree, and rock outcrops.

III.C.2.b. Road Construction

1. Use state highway and U.S. Forest Service road design and construction criteria for permanent roads. Use minimum standards dictated by the type and use of road. Close, water-bar, and hydroseed temporary roads.

2. Build single-lane roads or single-lane roads with turnouts.

3. Minimize permanent road building and coordinate with existing and planned road systems.

4. Minimize road length.

5. Install proper drainage and base material.

6. Avoid riparian areas when feasible and install culverts and bridges when crossing streams.

7. Avoid damaging vegetation unnecessarily.

8. Include gate, cattle guard, bridge, and culvert specification in road construction contracts.

9. Off-road travel should be done only when it is the most environmentally compatible alternative.

10. Temporary road location should be selected primarily to minimize excavation and side-cost.

III.C.2.c. Tower Erection

1. Use the most environmentally compatible technique and equipment that will do the job.

2. Avoid narrow ridgetops and steep slopes for tower sites, and especially for angle or dead end towers.

3. The crane crew should manage crane pad construction; not the clearing crew.

4. Install guy anchors and counterpoise equipment with a view to minimizing disturbance.

5. Batch plant sites must comply with public health requirements.

III.C.2.d. Conductor Stringing

1. Lift tower electrical hardware by pulling with winch rather than cross-country vehicle.

2. Fly in sockline by helicopter.
3. Mutually locate and agree on pulling sites and splice points at the same time tower sites are staked.
4. Use self-propelled spacing buggies (wire trollies used to install spacers on conductors).

III.C.2.e. Restoration

1. Conduct a thorough and complete clean-up.
2. Hydroseed scarified areas as specified in inventory.
3. Build erosion barriers as necessary.
4. Repair and restore fences, gates, cattle quards, etc.
5. Close all temporary roads.
6. Bring all permanent roads up to standard for future maintenance.

III.C.2.f. Maintenance

1. Allow no blanket application of herbicides or insecticides.
2. Inspect for environmental damage or inadequate restoration, and correct defects.
3. On agricultural lands, maintenance should be performed in a manner to reduce crop or pasture damage.
4. If roads are reopened and again closed, repeat hydroseeding and rebuild erosion barriers if necessary.
5. Manual tree removal is preferable to a mechanical treatment.

III.C.2.g. General

1. Obtain a complete list of equipment types, crew sizes, and planned construction sequence.
2. Comply with all local, state, and federal environmental and sanitary requirements.
3. Comply with the U.S. Department of Agriculture and the U.S. Department of the Interior construction guidelines throughout the line length. Use these as a model for state and private lands.

4. Require a complete maintenance plan and agree on allowable procedure.

5. Correct all latent defects to roads, fences, gates, crops, excavation, restoration, and other construction or maintenance activities for a period beyond the end of construction for at least five years, and preferably for the entire lifetime of line.

6. Brief all contractor supervisors and employees on environmental constraints prior to and during construction, orally and written, formally and informally. Post reminders on job sites.

7. Have sufficient technically qualified engineering inspectors on the ground from the beginning with authority to enforce compliance, and to protect the environment.

8. Explain that unwarranted damage, particularly in earthmoving, will be cause for contract extension and additional cost, as the line must be constructed with minimal environmental degradation.

9. Government officials of cities and counties along the transmission line route should be given advance notice of the phases of construction, the crew size anticipated for each phase at that locale, the period and length of time that the crews will be in the vicinity, and an estimate of the number of school children accompanying the crews.

6.3.2.5. Fauna

I. Introduction

The non-domestic animals of the Clyde Park-Dillon study area include a wide variety of terrestrial and aquatic species, which have been categorized in this study into five groups: aquatic macro-invertebrates, fish, herpetofauna, birds, and mammals. A great deal of inventory information is available for these animals, including preferred habitat, distribution within the study area, and major food sources. Such information is included in this study in summary form; more extensive and detailed data can be found in the Technical Appendix I. For convenience, similar detailed information has been compiled into inventory tables (Tables 6-5, 6-6, 6-7, 6-8, and 6-9).

The second part of the inventory data is a discussion of parameters relevant to transmission line siting and impacts evaluation. They pertain to the value, vulnerability, and ecology of individual species in the study area.

The last major section within this study on fauna is a thorough consideration of possible impacts upon the aquatic and terrestrial fauna of the study area through disturbances associated with construction of a transmission line. Sources of possible impacts upon aquatic fauna discussed are: sedimentation, alteration of streamflow, organic debris, thermal pollution, and sanitary waste and toxic material. Impacts upon terrestrial fauna are expected to result from: displacement, mortality, habitat alteration, stress, and a number of indirect impacts. For each possible adverse impact mentioned for both aquatic and terrestrial fauna, mitigating measures are suggested.

II. Inventory

II.A. Fauna Data Summary

The inventory data presented in the text, as well as in the inventory tables, were compiled from published studies, Montana Department of Fish and Game Job Progress and Completion Reports, conversations with professionals representing a number of agencies, and a limited amount of field work by the Energy Planning Division personnel. Big game mammal and upland game bird maps were prepared primarily by personnel of the Montana Department of Fish and Game; a list of contributors to each sector of each map is given in Technical Appendix I. Field-checking of the study area was carried out concurrently with other aspects of the inventory.

II.A.1. Aquatic Macro-Invertebrates

The wide variety of habitats found in the aquatic systems of the study areas provides for a diverse macro-invertebrate fauna. Aquatic insects are one of the major components of benthic macro-invertebrate communities, and form complex interrelationships with the physical and chemical factors that shape a stream drainage. These insects are particularly suitable as indicators of physical and chemical changes in the aquatic ecosystem, since their very specific habitat perference and relatively low mobility renders them especially sensitive to foreign substances entering the aquatic environment.

Studies of trout food habits have consistently shown that under normal stream conditions the bulk of the diet of adult trout consists of aquatic invertebrates, mainly aquatic insects.

II.A.2. Fish

The sport fisheries of the study area provide an important economical and recreational resource (see Figure 6-6). Detailed fisheries information, including fish population estimates, gill netting and electrofishing results, creel censuses, fishing pressure estimates, and existing management problems, has been inventoried for the major rivers, tributary streams, and lakes and reservoirs of the study area. A discussion of these data, arranged by major river drainage, is presented in Technical Appendix I. The major river drainages (or portions of drainages) inventoried for this study include the Big Hole River, Beaverhead River (including the Ruby River), Jefferson River, Madison River, Gallatin River (East and West), and Yellowstone River (including a portion of the Shields River). Table 6-5 summarizes inventory data for 25 fish species known to inhabit waters of the study area.

Four species of native game fish are found in the waters of the study area: cutthroat trout, mountain whitefish, arctic grayling, and burbot or ling. The distribution of cutthroat trout and arctic grayling has declined substantially, probably due to man-caused habitat alteration and competition from introduced rainbow, brook, and brown trout in the major rivers of the study area. The arctic grayling, designated as a threatened species by the United States Bureau of Sport Fisheries and Wildlife (1973), has been reduced to a remnant population in the Madison River near Ennis. The distribution of mountain whitefish is widespread and includes all major rivers; migratory populations of these fish provide a major winter fishery in many areas, particularily along the Yellowstone River, Shields River, and the Beaverhead River. The burbot, recently granted game fish status by the Montana Department of Fish and Game (1975), is generally harvested lightly by sport fishermen.

Rainbow and brown trout, both introduced species, now comprise the major sport fisheries in the lower portions of the main rivers. Rainbow trout, along with cutthroat trout, generally provide the major fisheries in the upper portions of these rivers. Brook trout occur occasionally in the main rivers, but are generally restricted to the mountain lakes and tributaries, where, along with cutthroat trout, they provide an important local fishery.

Table 6-5 Summary of inventory data for fish known to occur in the Dillon-Clyde Park study area.

Species[1]	Abbr.[2]	Preferred Habitat	Distribution by Drainage[3]	Major Food Sources	Classif. and Status[4]	Spawning and Movements	Remarks	Sources[5]
Goldeye (Hiodon alosoides)	GE	Larger rivers and lakes and (rarely) cold mt. streams	- - - - - Y	Insects, molluscs, small fish	N	Probably spawns between Mar. and May in large muddy rivers	Known only from Shields and Yellowstone Rivers near Livingston	Workman 1975
Mountain whitefish (Prosopium williamsoni)	WF	Cold mountain streams, lakes, reservoirs	H B J M G Y	Aquatic insects, other invertebrates	G	Moves upstream in autumn to spawn in riffle areas	Major winter fishery in rivers of study area; abundant	Liebelt 1970 Workman 1975
Kokanee salmon (Oncorhynchus nerka)	Kok	Cold water lakes	- - - - - Y	Plankton, microcrustaceans, other invertebrates	G	Spawns in fall of fourth yr. of age; large schools move into tributaries to spawn	Known only from Dailey Lake	Workman 1975
Golden trout (Salmo aquabonita)[6]	Gt	Cold mountain streams & lakes between 6300 and 10,500 feet in elevation	- - - M G -	Aquatic insects, invertebrates	G	Spawns April-July; fish in lakes must move into tributaries to spawn	Known only from Golden Trout, Hilgard, and Louise Lakes	Vincent 1975
Cutthroat trout (Salmo clarki)	Ct	Cold mountain streams and lakes	- B J M G Y	Aquatic insects, other invertebrates, small fish	G	Spawns April-July; fish in lakes must move into tributaries to spawn	Competition from introduced species has reduced numbers	Hanzel 1959 Marcoux 1975
Rainbow trout (Salmo gairdneri)[6]	Rb	Lakes, ponds, reservoirs, major rivers	H B J M G Y	Aquatic insects, other invertebrates, small fish	G	Spawns April-July; fish in lakes must move into tributaries to spawn	Hybridizes readily with cutthroat trout	Marcoux 1975
Brown trout (Salmo trutta)[6]	LL	Valley portions of larger rivers; lakes, reservoirs	H B J M G Y	Aquatic insects, sculpins, trout fingerlings	G	Spawns Oct.-Dec.; fish in lakes must move into tributaries to spawn	Has excellent growth rates; popular with fishermen	Marcoux 1975
Brook trout (Salvelinus fontinalis)[6]	Eb	Small spring fed streams or ponds	H B J M G Y	Aquatic insects, other invertebrates, small fish	G	Spawns September-October	Popular with local stream fishermen	Peterson 1975
Lake trout (Salvelinus namaycush)	Lt	Deep, cold lakes	- - - - G -	Aquatic invertebrates, smaller fish incl. trout	G	Spawns Oct.-Nov. on rocky shoals as deep as 120 ft.	Introduced to Mystic Lake	Poore 1972 Vincent 1975
Arctic grayling (Thymallus arcticus)	Gr	Cold mountain streams, lakes, reservoirs	- - - M G -	Aquatic insects, other invertebrates	G T	Spawns in spring; fish in lakes must move into tributaries to spawn	Known only from the Madison River and Hyalite Creek	Marcoux 1975
Carp (Cyprinus carpio)[6]	Carp	Warm, shallow water with abundant vegetation	- B - M - Y	Various	N	Spawns May-June in quiet, shallow, reedy areas of larger rivers	Known from lower Beaverhead R., Madison R. below Ennis L., Yellowstone R. near Livingston	Workman 1975; Berg and Peterman 1974
Lake Chub (Couesius plumbeus)	-	Streams at lower elevations, some mountain lakes	- - - - - Y	Plankton, small aquatic invertebrates	N	Spawns May-June; may migrate into tributary streams	Rare; probably introduced into mountain lakes by fishermen	Workman 1975
Longnose dace (Rhinichthys cataractae)	Dace	Various; includes muddy intermittent streams and fast mountain streams	H B J M G Y	Aquatic insects, fish eggs, algae	N	Spawns in late spring and early summer in shallow riffle areas		Berg and Peterman 1974

Table 6-5 (continued)

Species1/	Abbr.2/	Preferred Habitat	Distribution by Drainage3/	Major Food Sources	Classif. and Status4/	Spawning and Movements	Remarks	Sources5/
Shorthead redhorse (*Moxostoma macrolepidotum*)	-	Shallow water in larger rivers with intermediate temperatures	- - - - - Y	Aquatic insects, other invertebrates	N	Spawns in April and May in tributaries	Known only from Yellowstone River near Livingston	Workman 1975
Longnose sucker (*Catostomus catostomus*)	LNSu	Clear cold streams and lakes, also warm, turbid drainages	H B - M G Y	Algae, midge larvae and other aquatic insects	N			Berg and Peterman 1974
White sucker (*Catostomus commersoni*)	WSu	Various; cold to warm waters with high to low turbidities	H B - M G Y	Aquatic invertebrates	N	Spawns April-June; upstream movement has been noted	Reaches greatest abundance in man-made impoundments such as Ruby Reservoir	
Mountain sucker (*Catostomus platyrhynchus*)	JSu	Cold streams with clean rubble, gravel, or sand bottoms	- B - M G Y	Diatoms, algae, aquatic plants, invertebrates	N	Spawns in June and July	An important forage fish for trout in some waters	Hauser 1968
Stonecat (*Noturus flavus*)	-	Larger rivers	- B - - - -	Aquatic insects, small fish	N	Spawns in July and August	Known only from Warmsprings Cr., Madison Co.	
Burbot (*Lota lota*)	Ling	Larger cold-water streams, lakes, reservoirs	H B J - - -	Aquatic organisms including small fish	G	Spawns most often in February in water 1-10 ft. deep	Lightly utilized by fishermen	Peterson 1975
Shortfin molly (*Poecilia mexicana*)6/	-	Warm springs or ponds	- B - - - -	Plants, aquatic organisms	N	May have several broods during a year	Exotic; known only from Trudau Pond	
Variable platyfish (*Xiphophorus variatus*)6/	-	Warm ponds or springs	- B - - - -	Plants, small aquatic organisms	N	May have several broods during a year	Exotic	
Green swordtail (*Xiphophorus helleri*)6/	-	Warm ponds or springs	- B - - - -	Plants, small aquatic organisms	N	May have several broods during a year	Exotic	
Black Crappie (*Pomoxis nigromaculatus*)6/	CR	Large clear streams, lakes and reservoirs	- - - - - Y	Aquatic invertebrates, small fish	N	Spawns from May to June in sandy areas	Known only from Dailey Lake	
Yellow perch (*Perca flavescens*)6/	YP	Cool, clear ponds or streams with abundant vegetation	- - - - G Y	Aquatic invertebrates	N	Spawns April-May over aquatic vegetation		
Mottled sculpin (*Cottus bairdi*)	COT	Riffle areas of clear, fast streams with rocky bottoms	H B J M G Y	Aquatic insects	N	Spawns from May to June in riffle areas	An important source of food for trout	Berg and Peterman 1974; Workman 1975

1/ Nomenclature follows that of Brown (1971)
2/ Standard abbreviations adopted by the Montana Department of Fish and Game (Fisheries Field Handbook, 1974)
3/ H = Big Hole Drainage, B = Beaverhead Drainage, J = Jefferson Drainage, M = Madison Drainage, G = Gallatin Drainage, Y = Upper Yellowstone Drainage. Letters indicate known occurrence within each drainage in the study area.
4/ G = game species, N = nongame species, T = threatened species
5/ Brown (1971) was used as a source throughout; additional sources are listed.
6/ Species not native to Montana

Figure 6-6. Several major rivers within the study area have outstanding sport fisheries. (Photo courtesy of Montana State Fish & Game Department.)

Among the most widely distributed non-game fish are the longnose dace, longnose sucker, white sucker, mountain sucker, and the mottled sculpin. The longnose dace and mottled sculpin provide an important forage source for the game fish populations.

Included in the study area is a large percentage of the total miles of Class One or "Blue-Ribbon" fishery streams in the state. These streams have excellent populations of sport fish and receive an appreciable amount of fishing pressure. Many more miles of high quality fishery streams are also present and have been variously classified (see Technical Appendix I).

Misuse and abuse of the rivers, streams, lakes, and reservoirs of the study area is preventing many areas from reaching their full sport fishery potential. Management problems along the main rivers and their tributaries affecting the fisheries include overgrazing, irrigation dewatering, and channel alterations associated with flood control and irrigation diversions. Other problems include excessive timber removal and real estate developments. Adherence to proper land management policies from both public and private land owners is essential if future damage to the fisheries of the area is to be prevented (see Figure 6-7).

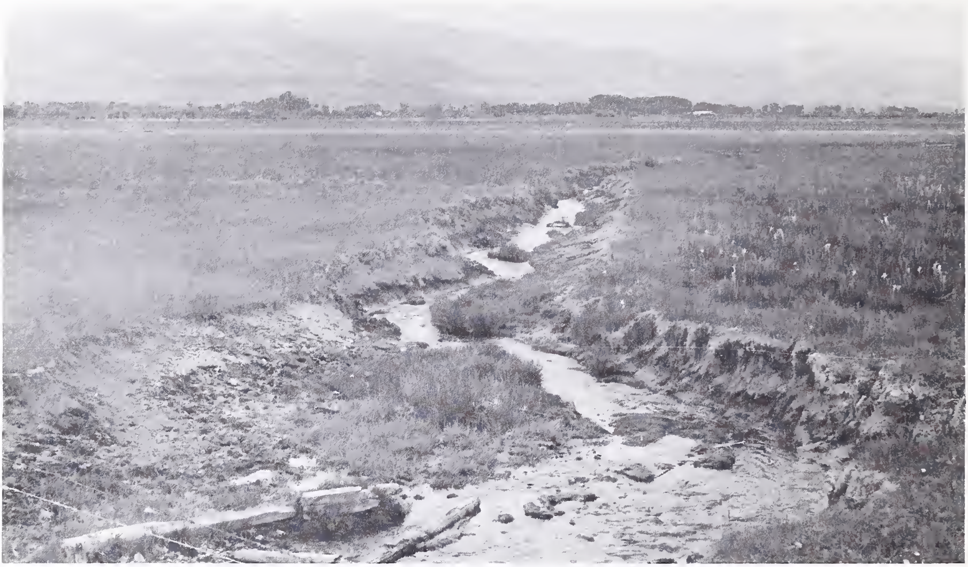


Figure 6-7. Throughout the study area, many tributary streams have a reduced fishery potential because of past improper land management techniques.

II.A.3. Herpetofauna

Inventory data for the seven species of amphibians and seven species of reptiles (none of which are threatened or endangered) known to occur in the study area are summarized in Tables 6-6 and 6-7. Data are also presented for two species of amphibians and four species of reptiles which are known from areas adjacent to the study area, but whose occurrence within the study area has not been verified.

II.A.4. Birds

Inventory data for 233 bird species of regular occurrence in the study area are summarized in Table 6-8. Information on distribution and breeding status is presented by latilong according to the system used by Skaar (1975). A latilong is a geographical area bounded by adjacent lines of latitude and longitude (parallels and meridians). The study area is located entirely within the Dillon, Bozeman, and Livingston latilongs; information is given in Table 6-8 for these three latilongs plus the adjacent Lima and West Yellowstone latilongs. In Table 6-8, each of the five symbols given for each species in the "Distribution and Breeding Status by Latilong" column represents the status of a given bird species in one of five latilongs. The order of presentation is: Dillon, Bozeman, Livingston, Lima, West Yellowstone. Breeding status is indicated for each latilong by letters, according to the list of abbreviations below:

TABLE 6-6

Summary of Inventory Data for Amphibians of Known or Hypothetical Occurrence in the Dillon to Clyde Park Study Area

Species 1/	Preferred Habitat	Distribution Within the Study Area	Major Food Sources	Remarks	Sources 2/
Tiger salamander (Ambystoma tigrinum)	Moist places under logs or rocks near water (adults); ponds and lakes (larvae)	Widespread; most records are from mid elevations in the Madison Drainage, with one record near Dillon	Worms, slugs, insect larvae	See text	Micken 1968, 1971; Anderson 1975; Craig 1974
*Tailed frog (Ascaphus truei)	Cold, swift mountain streams with numerous waterfalls	Unknown	Insects	The study area lies southeast of the known range of this species; may occur in Tobacco Root Mts.	Black 1970a; Brunson 1975
Plains spadefoot toad (Scaphiopus bombifrons)	Arid plains grassland with loose sandy or gravelly soil	Known only from the vicinity of Dillon	Insects	Fossorial; commonly breeds in irrigation ditches	Miller 1975; Black 1970a
*Great Basin spadefoot toad (Scaphiopus hammondi)	Sagebrush and shortgrass prairie to spruce-fir forests	Unknown	Insects	A Great Basin species; range may extend into extreme southern Montana. Fossorial.	Miller 1975; Black 1971
Western toad (Bufo boreas)	Moist areas near water; high meadows	Widespread	Insects	Common; has been collected at elevations of over 9500 ft. northwest of Dillon	Miller 1975; Black 1970a, 1971
Woodhouse's toad (Bufo woodhousei)	Various; includes short-grass prairie and coniferous forests bordering rivers and streams	Widespread	Insects	Found in forests at 7000 ft. in the Gallatin Range near Bozeman	Miller 1975; Black 1970a, 1971
Chorus frog (Pseudacris triseriata)	Near lakes, ponds, swampy areas	Widespread	Insects		Black 1970a
Spotted frog (Rana pretiosa)	Near lakes, streams, ponds at mid elevations in forested areas	Widespread	Insects		Middendorf 1957; Black 1969
Leopard frog (Rana pipiens)	Along ponds, rivers, lakes, springs, creeks, temporary pools	Probably restricted to the eastern portion of the study area; one doubtful record exists for the Dillon area	Insects		Black 1969

1/Nomenclature follows Conant et al. (1956) and Brunson (1955).

2/Stebbins (1966), Timken (1974) were used as sources throughout; other sources are listed.

* Hypothetical in the study area.

TABLE 6-7

Summary of Inventory Data for Reptiles of Known or Hypothetical Occurrence in the Dillon-Clyde Park Study Area

Species[1]	Preferred Habitat	Distribution Within the Study Area	Major Food Sources	Remarks	Sources[2]
Painted turtle (Chrysemys picta)	Lakes, ponds, rivers, streams and adjacent shores, generally below 6000 feet	Widespread	Plants, crayfish, snails, tadpoles, small fish	Uncommon; hibernates during winter in mud or debris	Black 1970b
*Short-horned lizard (Phrynosoma douglassi)	Semi-arid plains and sagebrush to coniferous forests	Unknown	Insects	Fairly common in adjacent areas; has not been verified in the study area	Brunson 1975; Flath 1975
*Sagebrush lizard (Sceloporus graciosus)	Sagebrush, river bottoms, dry rocky areas	Unknown	Insects	Known from thermal areas in Yellowstone Park near Gardiner; possibly found in Paradise Valley	Brunson 1975; Moore 1975
*Western skink (Eumeces skiltonianus)	Open areas with rocks or debris	Unknown	Insects	Known from extreme southwestern Montana; possibly occurs in the study area	Brunson 1975
Rubber boa (Charina bottae)	Talus slopes near moist areas; along forested streams	Widespread	Small mammals, insects		Brunson 1975
Racer (Coluber constrictor)	Fields, meadows, breaks in timbered areas, grassland, rocky outcrops	Known only from Gallatin Co., but may occur near outcrops along Jefferson R.	Rodents, frogs, young birds, insects, other snakes		
Gopher snake (Pituophis melanoleucus)	Prairie grassland, river valleys, talus slopes, rocky outcrops below 7000 feet	Widespread	Rodents, rabbits, birds, eggs		
Western garter snake (Thamnophis elegans)	Near streams and ponds at low to mid elevations	Widespread	Slugs, leeches, mice, fish, frogs, toads		
*Plains garter snake (Thamnophis radix)	Prairie ponds and lakes	Unknown	Frogs, insects, mice, earthworms	Common in eastern Montana; may range into the study area	
Common garter snake (Thamnophis sirtalis)	Water areas, rocky outcrops at low to mid elevations	Widespread	Frogs, toads, slugs, insects		
Western rattlesnake (Crotalus viridis)	Rocky hillsides, outcrops, open prairie, hayfields	Widespread	Rodents, frogs, birds	The only poisonous snake in the study area; congregates in dens in winter	

[1] Nomenclature follows Conant et al. (1956) and Brunson (1955).

[2] Stebbins (1966), Timken (1974), and the Montana Department of Fish and Game (no date) were used as sources throughout; other sources are listed.

* Hypothetical in the study area.

TABLE 6-8

Summary of Inventory Data for Bird Species of Regular Occurrence in the Dillon to Clyde Park Study Area[1]

Species[2]	Preferred Habitat	Major Food Sources	Classif. and Status[3]	Distribution and Breeding Status[4]					Abundance, Bozeman Latilong[4]			
				Dil	Boz	Liv	Lim	Yel	Spr	Sum	Fal	Win
Common Loon (*Gavia immer*)	Large lakes and rivers in coniferous forests	Fish, other aquatic organisms	N	m	m	m	m	m	6	0	6	-
Red-necked Grebe (*Podiceps grisegena*)	Lakes	Small fish, aquatic invertebrates	N	-	m	m	-	-	0	-	0	-
Horned Grebe (*Podiceps auritus*)	Lakes, marshy ponds	Small fish, aquatic invertebrates	N	1	m	m	-	m	6	0	7	0
Eared Grebe (*Podiceps caspicus*)	Lakes, ponds, marshy borders	Small fish, aquatic invertebrates	N	b	b	t	B	B	12	6	10	-
Western Grebe (*Aechmophorus occidentalis*)	Larger lakes	Small fish, aquatic invertebrates	N	b	B	t	b	B	7	6	6	-
Pied-billed Grebe (*Podilymbus podiceps*)	Marshy ponds, lakes, irrigation ditches	Small fish, aquatic invertebrates	N	1	B	t	b	B	-	7	-	-
White Pelican (*Pelecanus erythrorhynchos*)	Larger lakes	Fish, crustaceans	N	-	t	t	t	t	7	4	7	-
Double-crested Cormorant (*Phalacrocorax auritus*)	Lakes and larger rivers	Fish, crustaceans	N	B	B	-	t	t	-	5	-	-
Great Blue Heron (*Ardea herodias*)	Rivers, streams, marshes, mudflats	Fish, frogs, crayfish, mice, insects	N	B	B	B	b	B	7	7	8	0
Black-crowned Night Heron (*Nycticorax nycticorax*)	Marshes, lakes, shores	Fish, other aquatic organisms	N	-	t	t	b	B	0	-	0	-
American Bittern (*Botaurus lentiginosus*)	Marshes, reedy lakes	Fish, other aquatic organisms	N	b	b	t	b	B	-	0	-	-
Mute Swan (*Cygnus olor*)	Lakes, large rivers, ponds	Aquatic plants and invertebrates	M	-	t	B	-	-	-	-	-	-
Whistling Swan (*Olor columbianus*)	Lakes, large rivers, fields, ponds	Aquatic plants and invertebrates	M	t	t	t	t	t	8	-	8	-
Trumpeter Swan (*Olor buccinator*)	Lakes, large rivers, ponds	Aquatic plants and invertebrates	M	t	B	t	B	B	5	2	5	2
Canada Goose (*Branta canadensis*)	Lakes, marshes, rivers, grainfields	Grasses, seeds, grain, aquatic organisms	M	B	B	B	B	B	9	7	11	7
Snow Goose (*Chen hyperborea*)	Marshes, prairies, ponds, grainfields	Grain, grasses, insects, berries	M	m	m	m	1	m	2	-	5	-
Mallard (*Anas platyrhynchos*)	Marshes, ditches, ponds, grainfields, rivers	Grain, aquatic plants and invertebrates	M	B	B	B	B	B	14	12	14	12
Gadwall (*Anas strepera*)	Lakes, ponds, marshes, rivers	Grain, aquatic plants, grasses	M	t	B	t	b	B	8	6	9	1
Pintail (*Anas acuta*)	Marshes, ponds, lakes, grainfields	Grain, aquatic plants, grasses	M	t	B	t	b	B	12	4	9	5
Green-winged Teal (*Anas carolinensis*)	Small streams, ponds, lakes, marshes	Grain, aquatic plants, grasses	M	t	B	t	t	B	9	8	10	6
Blue-winged Teal (*Anas discors*)	Marshy borders of lakes, ponds, streams	Grain, aquatic plants, grasses	M	b	B	t	b	B	11	10	11	-
Cinnamon Teal (*Anas cyanoptera*)	Marshy borders of lakes, ponds, streams	Grain, aquatic plants, grasses	M	t	B	t	b	B	7	6	-	-
American Wigeon (*Anas americana*)	Lakes, ponds, open streams	Grain, aquatic plants, grasses	M	t	B	t	t	B	11	5	12	5
Northern Shoveler (*Anas clypeata*)	Marshy borders of lakes and ponds	Grain, aquatic plants, grasses	M	t	B	t	b	B	10	6	10	1
Wood Duck (*Aix sponsa*)	Quiet sloughs in cottonwood forests	Grain, aquatic plants, grasses	M	B	B	-	-	-	-	4	-	0
Redhead (*Aythya americana*)	Lakes, ponds	Small aquatic plants and invertebrates	M	t	B	t	b	B	12	6	10	-

Table 6-8 (continued)

Species[2/]	Preferred Habitat	Major Food Sources	Classif. and Status[3/]	Distribution and Breeding Status[4/]					Abundance, Bozeman Latilong[4/]			
				Dil	Boz	Liv	Lim	Yel	Spr	Sum	Fal	Win
Ring-necked Duck (*Aythya collaris*)	Wooded lakes and ponds	Small aquatic plants and animals	M	-	t	t	t	B	5	1	5	-
Canvasback (*Aythya valisineria*)	Lakes, ponds, rivers, streams	Small aquatic plants and animals	M	t	t	t	t	B	12	1	9	0
Lesser Scaup (*Aythya affinis*)	Lakes, ponds	Small aquatic plants and animals	M	t	b	t	b	B	12	4	12	1
Common Goldeneye (*Bucephala clangula*)	Lakes, rivers	Small aquatic plants and animals	M	m	m	m	m	m	13	0	13	12
Barrow's Goldeneye (*Bucephala islandica*)	Wooded lakes, ponds, rivers	Small aquatic plants and animals	M	-	t	b	t	B	6	5	6	3
Bufflehead (*Bucephala albeola*)	Lakes, ponds	Small aquatic plants and animals	M	-	t	t	t	B	8	0	8	2
Harlequin Duck (*Histrionicus histrionicus*)	Turbulent mountain streams	Small aquatic plants and animals	M	-	b	b	-	-	2	-	2	-
Ruddy Duck (*Oxyura jamaicensis*)	Marshy borders of lakes and ponds	Small aquatic plants and animals	M	t	B	t	b	b	12	6	11	-
Hooded Merganser (*Lophodytes cucullatus*)	Wooded lakes, ponds	Fish	M	-	m	m	m	m	1	-	1	-
Common Merganser (*Mergus merganser*)	Wooded lakes, rivers, ponds	Fish	M	b	B	B	t	b	10	8.	10	8
Red-breasted Merganser (*Mergus serrator*)	Larger lakes, ponds, rivers	Fish	M	m	m	m	m	m	12	-	11	-
Turkey Vulture (*Cathartes aura*)	Riparian woodlands, fields, cliffs	Carrion	N	b	B	t	-	-	-	3	-	-
Goshawk (*Accipiter gentilis*)	Coniferous forests	Birds, small mammals	N	b	B	t	t	b	-	7	-	7
Sharp-shinned Hawk (*Accipiter striatus*)	Forests, thickets, foothills	Birds, small mammals	N	t	b	B	-	b	8	7	8	6
Cooper's Hawk (*Accipiter cooperii*)	Forest edges in foothills	Birds, small mammals	N	-	b	b	t	b	-	6	-	5
Red-tailed Hawk (*Buteo jamaicensis*)	Open country, woodlands, deserts	Rodents, rabbits, small birds	N	b	B	B	b	b	11	10	11	5
Swainson's Hawk (*Buteo swainsoni*)	Dry prairie, open foothills, forests	Rodents, small birds, grasshoppers	N	b	B	b	t	b	-	7	-	-
Rough-legged Hawk (*Buteo lagopus*)	Open prairies, marshlands	Rodents, rabbits, small birds	N	w	w	w	w	w	-	-	-	10
Ferruginous Hawk (*Buteo regalis*)	Arid plains, grassland, cottonwood groves	Rodents, rabbits, small birds	NU	t	B	t	b	b	-	2	-	-
Golden Eagle (*Aquila chrysaetos*)	Open mountains, plains, foothills, canyons	Rabbits, yellow-belly marmots	N	b	B	B	b	b	-	7	-	7
Bald Eagle (*Haliaeetus leucocephalus*)	Wooded lakes, rivers	Dead or dying fish	N	b[5/]	B	b	t	B	-	3[5/]	-	5
Marsh Hawk (*Circus cyaneus*)	Marshes, fields, grasslands	Rodents, small birds	N	b	B	b	t	b	10	9	10	7
Osprey (*Pandion haliaetus*)	Rivers, lakes	Fish	NU	B	B	b	-	B	-	0	-	-
Prairie Falcon (*Falco mexicanus*)	Open mountains, canyons, grassland, deserts	Birds, rodents, insects	NT	b	B	B	t	B	-	4	-	7
Peregrine Falcon (*Falco peregrinus*)	Open mountains, canyons, cliffs	Birds	NE	t	B	t	-	B	-	3	-	3
Merlin (*Falco columbarius*)	Open woodlands, prairie, marshes	Birds, rodents	NU	1	b	b	-	t	-	4	-	6
American Kestrel (*Falco sparverius*)	Open grassland, deserts, cropland, canyons	Grasshoppers, small birds, rodents	N	b	B	B	b	B	12	11	12	5

Table 6-8 (continued)

Species[2]	Preferred Habitat	Major Food Sources	Classif. and Status[3]	Distribution and Breeding Status[4]					Abundance, Bozeman Latilong[4]			
				Dil	Boz	Liv	Lim	Yel	Spr	Sum	Fal	Win
Blue Grouse (Dendragapus obscurus)	Coniferous forests, adjacent grassland	Conifer needles, pine nuts, vegetation	G	B	B	B	B	B	-	11	-	11
Spruce Grouse (Canachites canadensis)	Spruce-fir and lodgepole forests	Conifer needles, insects, berries	G	B	-	-	-	-	-	-	-	-
Ruffed Grouse (Bonasa umbellus)	Deciduous thickets of mountains, rivers	Buds of trees and shrubs, insects	G	B	B	B	B	B	10	10	10	10
Sharp-tailed Grouse (Pedioecetes phasianellus)	Grassland, thickets, forest edges	Grain, grasses	G	b	B	B	-	b	9	9	9	9
Sage Grouse (Centrocercus urophasianus)	Sagebrush areas	Big sagebrush, seeds	G	B	B	B	b	B	6	6	6	6
Ring-necked Pheasant (Phasianus colchicus)	Irrigated cropland, riparian shrubbery	Cultivated grain	G	b	B	B	-	-	11	11	11	11
Chukar (Alectoris graeca)	Rocky slopes, arid canyons, grassland	Grasses, forbs, grain, seeds, insects, fruit	G	1	b	-	-	-	5	5	5	5
Gray Partridge (Perdix perdix)	Open grassland, grain fields	Grain, seeds, insects	G	1	B	B	b	B	10	10	10	10
Turkey (Meleagris gallopavo)	Open woodlands	Seeds, fruits, berries, leaves, insects	G	1	-	B	-	-	-	-	-	-
Sandhill Crane (Grus canadensis)	Prairies, grainfields, marshes, mt. meadows	Various	M	B	B	b	B	B	-	6	-	-
Virginia Rail (Rallus limicola)	Marshes	Aquatic plants, insects, frogs	M	-	b	-	b	b	-	4	6	-
Sora (Porzana carolina)	Marshes, ditches, wet meadows	Aquatic plants and animals	M	b	B	b	b	B	10	8	10	-
American Coot (Fulica americana)	Ponds, lakes, marshes, fields	Aquatic plants and animals	M	b	B	t	b	B	13	9	14	-
Semipalmated Plover (Charadrius semipalmatus)	Shores	Mud-swelling insects, some vegetation	M	-	m	-	-	m	3	-	5	-
Killdeer (Charadrius vociferus)	Shores, fields, riverbanks, irrigated land	Mud-swelling insects, some vegetation	M	b	B	b	B	B	-	12	-	7
Black-bellied Plover (Squatarola squatarola)	Shores, open marshes	Mud-swelling insects, some vegetation	M	-	m	-	-	m	0	-	4	-
Common Snipe (Capella gallinago)	Marshes, ditches, wet meadows	Insects, crustaceans, molluscs, worms	M	B	B	B	b	B	-	11	-	6
Long-billed Curlew (Numenius americanus)	High grassland	Insects, crustaceans, molluscs, worms	UM	b	B	b	B	B	-	9	-	-
Upland Sandpiper (Bartramia longicauda)	Grassland, fields	Insects, crustaceans, molluscs, worms	M	-	B	b	-	?	-	0[5]	-	-
Spotted Sandpiper (Actitis macularia)	Shores, ponds, streamsides	Insects, crustaceans, molluscs, worms	M	b	B	B	b	b	-	11	-	-
Solitary Sandpiper (Tringa solitaria)	Streamsides, marshes, ponds	Insects, crustaceans, molluscs, worms	M	m	m	m	-	m	5	-	7	-
Willet (Catoptrophorus semipalmatus)	Shores of lakes and ponds, marshes	Insects, crustaceans, molluscs, worms	M	-	B	t	t	B	5	1	-	-
Greater Yellowlegs (Totanus melanoleucus)	Mudflats, sandbars	Insects, crustaceans, molluscs, worms	M	-	m	-	m	m	3	1	8	-
Lesser Yellowlegs (Totanus flavipes)	Mudflats, flooded fields	Insects, crustaceans, molluscs, worms	M	m	m	m	m	m	5	-	7	-
Pectoral Sandpiper (Erolia melanotos)	Grassy borders of mudflats, flooded fields	Insects, crustaceans, molluscs, worms	M	-	m	-	-	m	0	-	6	-
Baird's Sandpiper (Erolia bairdii)	Mudflats, lake shores	Insects, crustaceans, molluscs, worms	M	-	m	m	-	m	4	-	9	-
Least Sandpiper (Erolia minutilla)	Grassy margins of mudflats, flooded fields	Insects, crustaceans, molluscs, worms	M	-	m	m	-	m	5	-	7	-

Table 6-8 (continued)

Species[2]	Preferred Habitat	Major Food Sources	Classif. and Status[3]	Distribution and Breeding Status[4]					Abundance, Bozeman Latilong[4]			
				Dil	Boz	Liv	Lim	Yel	Spr	Sum	Fal	Win
Long-billed Dowitcher (*Limnodromus scolopaceus*)	Shallow water boundering mudflats	Insects, crustaceans, molluscs, worms	M	-	m	-	-	m	5	-	7	-
Stilt Sandpiper (*Micropalama himantopus*)	Ponds, shores, marshes	Insects, crustaceans, molluscs, worms	M	-	m	-	-	-	1	-	3	-
Semipalmated Sandpiper (*Ereunetes pusillus*)	Shores	Insects, crustaceans, molluscs, worms	M	-	m	-	-	m	-	-	4	-
Western Sandpiper (*Ereunetes mauri*)	Shores, marshes	Insects, crustaceans, molluscs, worms	M	-	m	-	-	m	2	-	4	-
Marbled Godwit (*Limosa fedoa*)	Grassland, ponds, mudflats, lakeshores	Insects, crustaceans, molluscs, worms	M	-	b	-	-	t	5	1	5	-
Sanderling (*Crocethia alba*)	Sandy shores	Insects, crustaceans, molluscs, worms	N	-	m	-	-	m	2	-	2	-
American Avocet (*Recurvirostra americana*)	Alakline lakes and ponds, marshes, shores	Insects, crustaceans, molluscs, worms	M	t	B	t	b	B	8	1	6	-
Wilson's Phalarope (*Steganopus tricolor*)	Shallow lakes, ponds, marshes, shores	Insects, crustaceans, molluscs, worms	N	b	B	t	b	B	10	9	10	-
Northern Phalarope (*Lobipes lobatus*)	Lakes, ponds, flooded fields	Plankton, aquatic insects	N	-	m	m	-	m	5	-	8	-
Herring Gull (*Larus argentatus*)	Lakes, fields, garbage dumps	Various	N	-	m	-	-	?	1	-	-	-
California Gull (*Larus californicus*)	Lakes, rivers, fields, ponds, dumps	Various	N	t	t	t	t	t	9	7	9	-
Ring-billed Gull (*Larus delawarensis*)	Lakes, rivers, fields, garbage dumps	Various	N	t	t	t	t	t	9	7	9	-
Franklin's Gull (*Larus pipixcan*)	Prairies, marshes, lakes, cultivated fields	Various	N	t	t	-	t	B	6	5	-	-
Bonaparte's Gull (*Larus philadelphia*)	Rivers, lakes, smaller ponds	Various	N	-	m	m	-	m	4	-	2	-
Forster's Tern (*Sterna forsteri*)	Marshes, lakes, ponds	Small fish, insects	N	-	t	t	t	B	3	-	3	-
Common Tern (*Sterna hirundo*)	Lakes, ponds	Small fish, insects	N	-	t	t	-	b	4	2	4	-
Black Tern (*Chlidonias niger*)	Marshes, lakes, ponds	Small fish, insects	N	t	t	-	t	b	5	3	-	-
Rock Dove (*Columba livia*)	Cities, farms, cliffs	Seeds, grain, fruits, insects	N	b	B	B	b	b	12	12	12	12
Mourning Dove (*Zenaidura macroura*)	Forests, farmland, grassland, deserts		N	b	B	B	b	b	-	14	-	2
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	Forest edges, river groves, riparian shrubbery	Catepillars, grasshoppers, other insects	N	b	b	b	-	t	-	9	-	-
Screech Owl (*Otus asio*)	Deciduous woodlands, farm groves	Rodents, birds, insects	N	-	B	b	-	-	-	5	-	5
Great Horned Owl (*Bubo virginianus*)	Coniferous and riparian forests, grassland		N	-	B	b	b	B	10	10	10	10
Pygmy Owl (*Glaucidium gnoma*)	Coniferous forests, wooded canyons		N	b	b	B	-	-	7	7	7	7
Burrowing Owl (*Speotyto cunicularia*)	Short-grass plains, deserts, prairie dog towns		UN	1	b	-	-	b	-	4	-	-
Great Gray Owl (*Strix nebulosa*)	Coniferous forests, adjacent meadows		N	-	b	b	-	-	-	5	-	5
Long-eared Owl (*Asio otus*)	Coniferous and riparian forests, thickets	Rodents, birds, insects	N	b	B	-	-	b	-	7	-	7
Short-eared Owl (*Asio flammeus*)	Grassland, marshes, fields		N	-	b	b	b	b	-	8	-	8

Table 6-8 (continued)

Species[2]	Preferred Habitat	Major Food Sources	Classif. and Status[3]	Distribution and Breeding Status[4]					Abundance, Bozeman Latilong[4]			
				Dil	Boz	Liv	Lim	Yel	Spr	Sum	Fal	Win
Saw-whet Owl (*Aegolius acadicus*)	Coniferous and riparian forests, farm groves	Rodents, birds, insects	N	1	B	b	-	b	-	7	-	7
Poor-will (*Phalaenoptilus nuttallii*)	Rocky, arid hills, sparse brush	Insects	N	-	t	t	-	-	-	-	3	-
Common Nighthawk (*Chordeiles minor*)	Forests, prairies, towns, lakes	Insects	N	b	B	b	t	b	-	9	10	-
White-throated Swift (*Aeronautes saxatalis*)	Dry mountains, canyons, cliffs along larger rivers	Insects	N	-	b	b	-	-	-	6	-	-
Broad-tailed Hummingbird (*Selasphorus platycercus*)	Mountain glades, high meadows, willow thickets	Flower nectar	N	-	?	t	-	b	-	-	-	-
Rufous Hummingbird (*Selasphorus rufus*)	Forest edges and openings, mountain meadows	Flower nectar	N	t	t	t	-	t	-	-	5	-
Calliope Hummingbird (*Stellula calliope*)	Thickety hillsides, forest openings in mountains	Flower nectar	N	b	b	B	-	b	-	10	-	-
Belted Kingfisher (*Megaceryle alcyon*)	Rivers, ponds, lakes, streams	Small fish	N	b	B	B	t	b	-	10	-	6
Common Flicker (*Colaptes auratus*)	Coniferous and riparian forests, farm groves	Tree-boring and other insects	N	B	B	B	b	B	-	13	-	8
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	Farm groves, open woodlands	Tree-boring and other insects	N	-	t	t	-	t	0	-	-	-
Lewis' Woodpecker (*Asyndesmus lewis*)	Riparian woodlands, forest edges, burns	Tree-boring and other insects	N	b	B	b	-	b	7	5	7	0
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	Cottonwood and aspen groves	Tree-boring and other insects	N	B	B	B	1	B	-	12	-	-
Williamson's Sapsucker (*Sphyrapicus thyroideus*)	Coniferous forests at high elevations, burns	Tree-boring and other insects	N	B	b	B	-	b	-	6	-	-
Hairy Woodpecker (*Dendrocopos villosus*)	Coniferous and riparian forests	Tree-boring and other insects	N	-	B	B	-	b	-	12	-	12
Downy Woodpecker (*Dendrocopos pubescens*)	Deciduous forests and thickets	Tree-boring and other insects	N	b	b	b	-	b	-	10	-	10
Black-backed 3-toed Woodpecker (*Picoides arcticus*)	Coniferous forests at high elevations	Tree-boring and other insects	N	b	b	B	-	-	-	5	-	5
Northern 3-toed Woodpecker (*Picoides tridactylus*)	Burned, diseased, or logged conifer forests	Tree-boring and other insects	N	b	B	b	-	-	-	10	-	10
Eastern Kingbird (*Tyrannus tyrannus*)	Forest edges, moist grassland, canyons, thickets	Flying insects	N	b	B	b	b	B	-	12	-	-
Western Kingbird (*Tyrannus verticalis*)	Open country, farms, grassland	Flying insects	N	b	B	b	t	t	-	10	-	-
Say's Phoebe (*Sayornis saya*)	Open arid country, brushy plains, farms	Flying insects	N	b	B	t	-	t	-	6	-	-
Willow Flycatcher (*Empidonax traillii*)	Willow thickets	Flying insects	N	b	b	b	b	b	-	13	-	-
Least Flycatcher (*Empidonax minimus*)	Cottonwood forests, aspen groves	Flying insects	N	-	B	b	-	-	-	7	-	-
Hammond's Flycatcher (*Empidonax hammondii*)	Dense coniferous forests at high elevations	Flying insects	N	b	b	B	-	b	-	12	-	-
Dusky Flycatcher (*Empidonax oberholseri*)	Open coniferous forests of foothills & lower mountains	Flying insects	N	b	b	B	b	b	-	15	-	-
Western Flycatcher (*Empidonax difficilis*)	Moist forest canyons, groves	Flying insects	N	1	b	b	-	t	-	7	-	-
Western Wood Pewee (*Contopus sordidulus*)	Mixed and deciduous forests	Flying insects	N	b	B	B	-	b	-	13	-	-
Olive-sided Flycatcher (*Nuttallornis borealis*)	Burned or logged coniferous forests	Flying insects	N	t	b	b	-	b	-	12	-	-

Table 6-8 (continued)

Species[2/]	Preferred Habitat	Major Food Sources	Classif. and Status[3/]	Distribution and Breeding Status[1/]					Abundance, Bozeman Latilong[4/]			
				Dil	Boz	Liv	Lim	Yel	Spr	Sum	Fal	Win
Horned Lark (Eremophila alpestris)	Arid short-grass plains, plowed fields	Seeds, insects	N	B	B	b	b	B	-	17	-	14
Violet-green Swallow (Tachycineta thalassina)	Open forests, canyons, cliffs, lakes	Flying insects	N	B	B	b	b	b	-	14	-	-
Tree Swallow (Iridoprocne bicolor)	Deciduous and mixed woodlands, mountain canyons	Flying insects	N	b	B	B	b	b	-	13	-	-
Bank Swallow (Riparia riparia)	Vertical soil cliffs, fields, marshes	Flying insects	N	B	B	b	-	B	-	13	-	-
Rough-winged Swallow (Stelgidopteryx ruficollis)	Near rivers, streams	Flying insects	N	B	B	b	b	b	-	12	-	-
Barn Swallow (Hirundo rustica)	Farms, fields, open woodlands	Flying insects	N	b	B	B	b	B	-	14	-	-
Cliff Swallow (Petrochelidon pyrrohonota)	Cliffs, rivers, lakes, canyons	Flying insects	N	B	B	b	b	B	-	12	-	-
Gray Jay (Perisoreus canadensis)	Coniferous forests, esp. at higher elevations	Various	N	1	b	B	-	b	9	9	9	9
Steller's Jay (Cyanocitta stelleri)	Montane coniferous forests	Various	N	-	B	b	t	b	11	11	11	11
Black-billed Magpie (Pica pica)	Farmland, foothills, open forests, thickets	Various	N	B	B	B	B	B	16	16	16	16
Common Raven (Corvus corax)	Mountains, foothills, valleys	Various	N	b	B	B	-	b	9	9	9	9
Common Crow (Corvus brachyrhynchos)	Foothills, valleys, canyons, dumps	Various	N	b	B	B	b	b	-	14	-	8
Pinyon Jay (Gymnorhinus cyanocephala)	Juniper and limber pine slopes	Various	N	t	B	B	-	-	8	8	8	8
Clark's Nutcracker (Nucifraga columbiana)	Montane coniferous forests, foothills	Various	N	B	B	B	b	B	13	13	13	13
Black-capped Chickadee (Parus atricapillus)	Mixed and deciduous forests, thickets	Insects, seeds, berries	N	b	B	b	b	b	13	13	13	13
Mountain Chickadee (Parus gambeli)	Montane coniferous forests, foothills	Insects, seeds, berries	N	B	B	B	1	b	15	15	15	15
White-brested Nuthatch (Sitta carolinensis)	Ponderosa pine and riparian forests	Bark insects, seeds	N	B	b	b	-	t	-	5[5/]	-	4
Red-breasted Nuthatch (Sitta candensis)	Montane coniferous forests, foothills	Bark insects, seeds	N	b	B	b	b	b	-	13	-	8
Brown Creeper (Certhia familiaris)	Montane coniferous forests, foothills	Bark insects	N	t	b	b	-	b	9	9	9	9
Dipper (Cinclus mexicanus)	Swift mountain streams	Aquatic invertebrates, small fish	N	b	B	B	-	b	11	11	11	11
House Wren (Troglodytes aedon)	Deciduous forests, riparian thickets	Insects, spiders	N	b	B	B	b	B	-	12	-	-
Long-billed Marsh Wren (Telmatodytes palustris)	Marshes, overgrown irrigation ditches	Insects, spiders	N	b	b	-	t	B	-	8	-	3
Canyon Wren (Catherpes mexicanus)	Cliffs, canyons rockslides	Insects, spiders	N	-	b	-	-	-	-	2	-	-
Rock Wren (Salpinctes obsoletus)	Rocky slopes, talus	Insects, spiders	N	B	B	B	b	b	-	13	-	-
Gray Catbird (Dumatella carolinensis)	Deciduous thickets, forest edges, underbrush	Insects, spiders	N	b	B	b	-	b	-	14	-	-
Sage Thrasher (Oreoscoptes montanus)	Sagebrush areas at all elevations	Insects, spiders	N	b	B	b	b	b	-	9	-	-
American Robin (Turdus migratorius)	Towns, lawns, forests, thickets	Insects, worms, berries, snails, fruits	N	B	B	B	B	B	-	16	-	8
Hermit Thrush (Hylocichla guttata)	Coniferous forests, high ridges	Insects, worms, berries, snails, fruits	N	b	b	B	b	b	-	12	-	-

Table 6-8 (continued)

Species2/	Preferred Habitat	Major Food Sources	Classif. and Status3/	Distribution and Breeding Status4/ Dil	Boz	Liv	Lim	Yel	Abundance, Bozeman Latilong4/ Spr	Sum	Fal	Win
Swainson's Thrush (*Hylocichla ustulata*)	Coniferous forests, riparian thickets	Insects, worms, berries, snails, fruits	N	b	B	B	-	b	-	14	-	-
Veery (*Hylocichla fuscescens*)	Willow thickets, deciduous forests	Insects, worms, berries, snails, fruits	N	b	b	b	-	b	-	14	-	-
Mountain Bluebird (*Sialia currucoides*)	Open areas in foothills and mountains	Insects, worms, berries, snails, fruits	N	B	B	B	B	B	-	12	-	-
Townsend's Solitaire (*Myadestes townsendi*)	Rocky outcrops, slide areas	Insects, worms, berries, snails, fruits	N	b	B	B	-	b	-	11	-	11
Golden-crowned Kinglet (*Regulus satrapa*)	Moist spruce-fir forests	Insects	N	b	b	b	-	t	-	8	-	8
Ruby-crowned Kinglet (*Regulus calendula*)	Coniferous and mixed forests	Insects	N	b	B	b	b	b	-	16	-	-
Water Pipit (*Anthus spinoletta*)	Alpine tundra	Insects, spiders, seeds	N	B	b	B	-	b	-	9	11	-
Sprague's Pipit (*Anthus spragueii*)	Short-grass prairie		N	-	b	-	-	-	-	3	-	-
Bohemian Waxwing (*Bombycilla garrula*)	Foothills, valleys	Berries, insects	N	w	w	w	-	w	-	-	14	12
Cedar Waxwing (*Bombycilla cedrorum*)	Forest edges and thickets	Berries, insects	N	b	B	B	-	t	-	11	-	3
Northern Shrike (*Lanius excubitor*)	Valleys, foothills, canyons	Insects, mice small birds	N	w	w	w	-	w	9	-	10	8
Loggerhead Shrike (*Lanius ludovicianus*)	Dry areas with scattered trees	Insects, mice small brids	N	b	b	-	-	t	-	7	-	-
Starling (*Sturnus vulgaris*)	Near human dwellings; valleys, canyons	Various; insects, berries, seeds	N	B	B	B	b	B	15	15	15	15
Solitary Vireo (*Vireo solitarius*)	Mixed forests	Insects	N	-	b	b	-	t	-	5	-	-
Red eyed Vireo (*Vireo olivaceus*)	Riparian forests, streams, canyons	Insects	N	b	B	b	-	t	-	9	-	-
Warbling Vireo (*Vireo gilvus*)	Mixed forests, thickets	Insects	N	B	B	b	b	b	-	16	-	-
Orange-crowned Warbler (*Vermivora celata*)	Aspen groves in foothills & lower mountains	Insects, some berries and fruit	N	b	b	b	-	-	-	12	-	-
Yellow Warbler (*Dendroica petechia*)	Willows, deciduous trees	Insects, berries	N	b	B	B	b	b	-	17	-	-
Yellow-rumped Warbler (*Dendroica coronata*)	Coniferous forests	Insects, spiders, fruits, seeds	N	b	B	b	b	b	-	16	-	-
Ovenbird (*Seiurus aurocapillus*)	Deciduous forests, thickets	Insects, snails, slugs, earthworms	N	-	b	b	-	-	-	-	-	-
Northern Waterthrush (*Seiurus noveboracensis*)	Forests and thickets bordering major streams	Aquatic insects, worms, molluscs	N	b	b	b	-	b	-	10	-	-
MacGillivray's Warbler (*Oporornis tolmiei*)	Dry thickets in foothills and mountains	Insects	N	b	b	b	b	b	-	15	-	-
Common Yellowthroat (*Geothlypis trichas*)	Marshes, streams, irrigation ditches	Insects	N	b	B	b	b	b	-	15	-	-
Yellow-breasted Chat (*Icteria virens*)	Willow thickets, moist canyons	Insects	N	b	b	-	-	t	-	7	-	-
Wilson's Warbler (*Wilsonia pusilla*)	Willow thickets along mountain streams	Insects	N	B	b	b	b	b	-	14	-	-
American Redstart (*Setophaga ruticilla*)	Riparian forests, mountain canyons	Insects, fruits, spiders	N	b	b	b	-	b	-	11	-	-

Table 6-8 (continued)

Species2/	Preferred Habitat	Major Food Sources	Classif. and Status3/	Distribution and Breeding Status4/					Abundance, Bozeman Latilong4/			
				Dil	Boz	Liv	Lim	Yel	Spr	Sum	Fal	Win
House Sparrow (*Passer domesticus*)	Near human habitations	Insects, seeds	N	b	B	B	b	b	15	15	15	15
Bobolink (*Dolichonyx oryzivorus*)	Hay meadows, fields	Insects, fruits, seeds, grain	N	b	b	b	-	t	-	11	-	-
Western Meadowlark (*Sturnella neglecta*)	Open fields, meadows, plains, prairies	Insects, fruits, seeds, grain	N	b	B	B	B	B	-	15	-	5
Yellow-headed Blackbird (*Xanthocephalus Xanthocephalus*)	*Scirpus* marshes	Insects, fruits, seeds, grain	N	b	B	B	B	B	-	9	-	-
Red-winged Blackbird (*Agelaius phoeniceus*)	Cattail marshes	Insects, fruits, seeds, grain	N	b	B	B	B	B	-	15	-	8
Northern Oriole (*Icterus galbula*)	Low-elevation deciduous forests	Insects, fruits, seeds, grain	N	b	B	B	-	t	-	11	-	-
Brewer's Blackbird (*Euphagus cyanocephalus*)	Irrigated farmland, open fields, cities, canyons	Insects, fruits, seeds, grain	N	b	B	b	b	b	-	16	-	6
Common Grackle (*Quiscalus quiscula*)	Major streams at low elevations, cropland	Insects, fruits, seeds, grain	N	b	B	b	-	-	-	11	-	0
Brown-headed Cowbird (*Molothrus ater*)	Along rivers, irrigated fields, foothills	Insects, fruits, seeds, grain	N	b	B	B	b	b	-	13	-	-
Western Tanager (*Piranga ludoviciana*)	Douglas fir forests	Insects, fruits	N	b	B	B	b	b	-	14	-	-
Black-headed Grosbeak (*Pheucticus melanocephalus*)	Deciduous forests & thickets in foothills	Insects, seeds, fruits	N	b	b	B	-	b	-	11	-	-
Lazuli Bunting (*Passerina amoena*)	Dry thickets in foothills & canyons	Insects, seeds	N	b	b	b	b	b	-	15	-	-
Evening Grosbeak (*Hesperiphona vespertina*)	Coniferous forests, towns	Seeds, dried fruits	N	b	b	B	-	b	-	13	-	
Cassin's Finch (*Carpodacus cassinii*)	Mixed & coniferous forests in mountains	Buds, fruits, seeds, conifer nuts	N	b	B	b	b	b	-	15	-	3
House Finch (*Carpodacus mexicanus*)	Towns, open forests, canyons, deserts	Seeds, fruits	N	b	b	t	b	-	-	5	-	-
Pine Grosbeak (*Pinicola enucleator*)	Coniferous forests near timberline	Wild fruits, conifer nuts	N	t	b	B	-	b	-	11	-	10
Gray-crowned Rosy Finch (*Leucosticte tephrocotis*)	Alpine tundra, open country	Insects, seeds	N	-	w	w	w	w	11	-	11	9
Black Rosy Finch (*Leucosticte atrata*)	Alpine tundra, open country	Insects, seeds	N	B	b	B	t	b	-	6	-	4
Common Redpoll (*Acanthis flammea*)	Weedy fields, conifer groves	Seeds	N	-	w	w	-	w	-	-	-	12
Pine Siskin (*Spinus pinus*)	Weedy fields, coniferous & mixed forests	Conifer nuts, seeds	N	b	B	b	b	b	-	16	-	6
American Goldfinch (*Spinus tristis*)	Riparian woodlands, willows, roadsides	Seeds, insects, fruit	N	b	B	b	b	b	-	14	-	4
Red Crossbill (*Loxia curvirostra*)	Montane confierous forests	Conifer nuts, fruits	N	-	B	b	-	b	-	12	-	7
White-winged Crossbill (*Loxia leucopters*)	Montane coniferous forests		N	t	b	b	-	-	-	4	-	4
Green-tailed Towhee (*Chlorura chlorura*)	Dry thickets in foothills, willow thickets	Seeds, berries, insects	N	b	B	B	b	b	-	11	-	-
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	Riparian forests, brushy hillsides	Seeds, insects	N	t	B	b	-	b	-	13	-	-
Lark Bunting (*Calamospiza melanocorys*)	Plains, prairies	Insects, seeds	N	t	B	t	-	t	-	3	-	-

Table 6-8 (continued)

Species[2]	Preferred Habitat	Major Food Sources	Classif. and Status[3]	Distribution and Breeding Status[4]					Abundance, Bozeman Latilong[4]			
				Dil	Boz	Liv	Lim	Yel	Spr	Sum	Fal	Win
Savannah Sparrow (Passerculus sandwichensis)	Moist hay fields, marshy pastures	Seeds, insects	N	b	B	b	b	B	-	14	-	-
Grasshopper Sparrow (Ammodramus savannarum)	Grassland, hay meadows, prairies	Insects (esp. grasshoppers)	N	-	b	-	?	-	-	5	-	-
Vesper Sparrow (Pooectes gramineus)	Dry grassland, sagebrush	Insects, seeds	N	b	B	B	b	b	-	17	-	-
Lark Sparrow (Chondestes grammacus)	Dry juniper hillsides, farms	Seeds, insects	N	-	B	-	-	b	-	8	-	-
Sage Sparrow (Amphispiza belli)	Sagebrush plains, dry brushy foothills	Insects, seeds	N	-	b	b	?	-	-	0[5]	-	-
Dark-eyed Junco (Junco hyemalis)	Coniferous and mixed forests	Seeds, insects	N	B	B	B	b	B	-	15	-	8
Tree Sparrow (Spizella arborea)	Weedy fields and thickets	Seeds	N	-	w	w	-	w	12	-	12	11
Chipping Sparrow (Spizella passerina)	Low-elevation mixed & coniferous forests	Insects, seeds	N	B	B	B	b	b	-	16	-	-
Clay-colored Sparrow (Spizella pallida)	Brushy prairies	Insects, seeds	N	b	b	t	-	-	-	3	-	-
Brewer's Sparrow (Spizella breweri)	Sagebrush areas at all elevations	Insects, seeds	N	b	B	B	b	b	-	12	-	-
Harris' Sparrow (Zonotrichia querula)	Brushy edges, open woodlands	Seeds	N	-	m	m	-	m	-	-	0	
White-crowned Sparrow (Zonotrichia leucophrys)	Coniferous forests, mountain thickets	Insects, seeds	N	b	B	B	b	b	-	15	-	-
Fox Sparrow (Passerella iliaca)	Mature willow thickets along mountain streams	Insects, seeds	N	b	b	b	-	b	-	8	-	-
Lincoln's Sparrow (Melospiza lincolnii)	Mt. meadows, willow thickets along mt. streams	Insects, seeds	N	B	b	b	-	b	-	14	-	-
Song Sparrow (Melospiza melodia)	Thickets & forests bordering streams & marshes	Insects, seeds	N	B	b	b	b	b	-	15	-	13
McCown's Longspur (Rhynchophanes mccownii)	Short-grass prairie	Insects, seeds	N	b	b	-	b	-	-	10	-	-
Lapland Longspur (Calcarius lapponicus)	Fields, prairies	Insects, seeds	N	-	w	w	-	-	10	-	10	7
Chestnut-collared Longspur (Calcarius lapponicus)	Plains, prairies	Insects, seeds	N	b	b	-	-	-	-	1	-	-
Snow Bunting (Plectrophanex nivalis)	Short-grass prairies, irrigated fields	Insects, seeds	N	w	w	w	-	w	10	-	10	7

1/ Casual and accidental species are listed in the Technical Appendix. More detailed information on colonial water birds, waterfowl, upland game birds, and raptors is presented in the text and in the Technical Appendix.

2/ Nomenclature follows the American Ornithologists' Union Check-list (1957) and the 32nd supplement to the A.O.U. Check-list (1973).

3/ G = upland game bird; M = migratory game bird; N = nongame bird (as classified by the Montana Department of Fish and Game 1974); E = endangered species; T = threatened species; U = status undetermined species (as classified by the U.S. Bureau of Sport Fisheries and Wildlife 1973).

4/ See text for explanation

5/ Most summer and breeding records for this species are old

SOURCES: Peterson 1969; Skaar 1969, 1975; Robbins et.al. 1966; Griscom and Sprunt 1957.

B = breeding confirmed (active nest or prefledgling young observed)

b = breeding indicated but not confirmed

t = occurs in latilong but breeding status unknown

m = migrant (passes through regularly only during migration; does not breed or winter in the latilong)

w = winters regularly in the study area; also passes through during migration, but does not breed

- = not reported; may or may not occur regularly

1 = records are probably, but not certainly, referrable to this latilong

? = records questionable

Estimated seasonal abundance for birds of the Bozeman latilong is also presented in Table 6-8, using the method of Skaar (1969). The number given for each season represents the base 2 logarithm of the lower limit of the estimated total population range; a dash may indicate either zero abundance or unknown abundance. Estimated total population ranges represented by these numbers are given in Technical Appendix I. Note that spring and fall abundances are not given for many summering or wintering birds, especially passerines, which migrate to and from the study area in spring and fall.

In addition to the birds listed in Table 6-8, an additional 55 species occur casually or accidentally in the study area. These species, listed in Technical Appendix I, do not normally breed, winter, or migrate in the study area, and have been observed only a few times in the last century within the three latilongs encompassing the study area.

Annual roadside censuses of breeding birds, supervised by the U.S. Bureau of Sport Fisheries and Wildlife (USBSF&W), have been conducted along three routes within the study area for a number of years; a summary of census data for each route from 1972-1975 is given in Technical Appendix I. These figures provide additional information on distribution and abundance of local breeding avifaunas, and can indicate year-to-year changes in abundances or species composition. Figure 6-8 shows times of biological activity for several reproductive sites used by birds.

Additional data for selected birds or groups of birds is presented in Technical Appendix I and is summarized below.

II.A.4.a. Colonial Water Birds

Large water birds, which typically return to traditional nesting colonies year after year, include the white pelican, double-crested cormorant, great blue heron, California gull, ring-billed gull, Franklin's gull and

TIMES OF BIOLOGICAL ACTIVITY OR HIGH SENSITIVITY TO DISTURBANCE AT SELECTED SEASONAL USE AREAS IN SOUTHWESTERN MONTANA

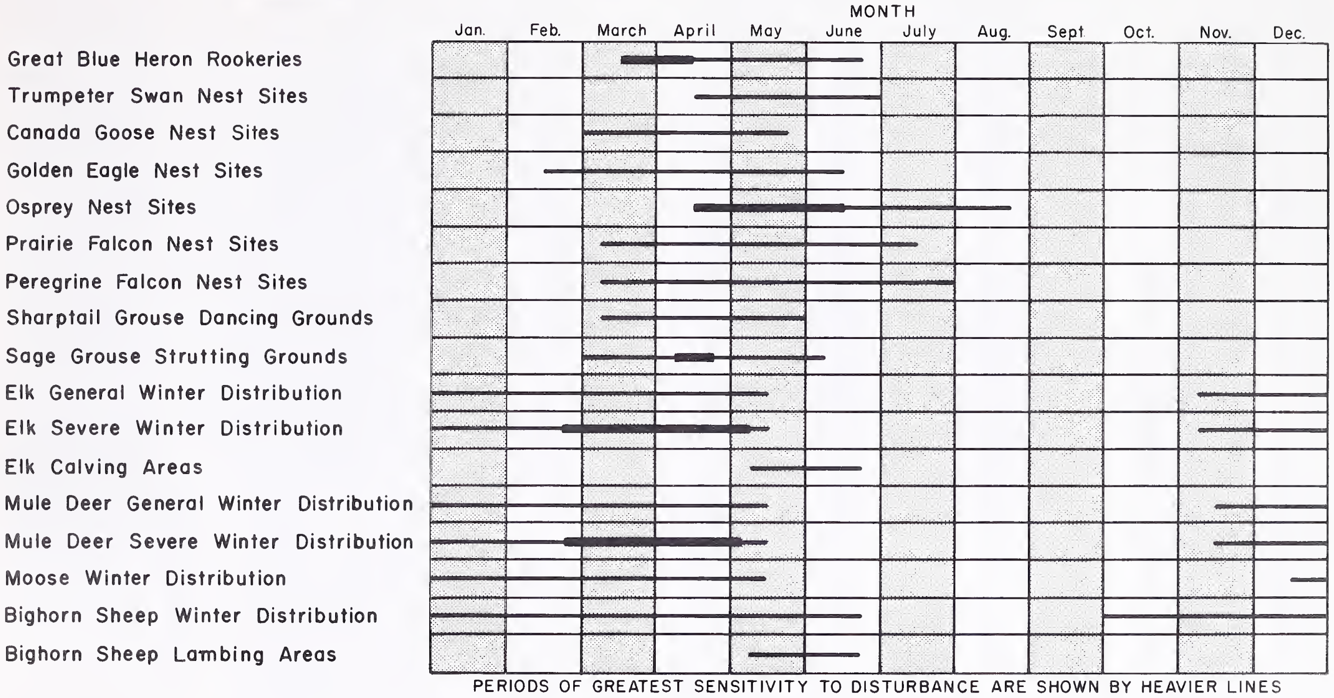


Figure 6-8

and common tern. However, although these species have been observed in the study area in summer, breeding has been confirmed only for the great blue heron and double-crested cormorant. Within the study area, these two species typically nest in tall, mature cottonwoods along major lakes or rivers; several nests are usually built in each tree. Nesting sites (rookeries) are particularly vulnerable to disturbance, and may be abandoned if disturbed early in the breeding season. Of nine heron rookeries located in the study area, three were abandoned in 1975.

II.A.4.b. Waterfowl

A total of 3 species of swans, 2 of geese, and 21 of ducks occurs regularly in the study area, concentrating near Three Forks, Ennis Lake, Willow Creek Reservoir, and larger rivers and stock ponds. The greatest abundance and variety of waterfowl is found during the spring and fall migrations, when large flocks stop over near water areas or in grain fields to feed and rest.

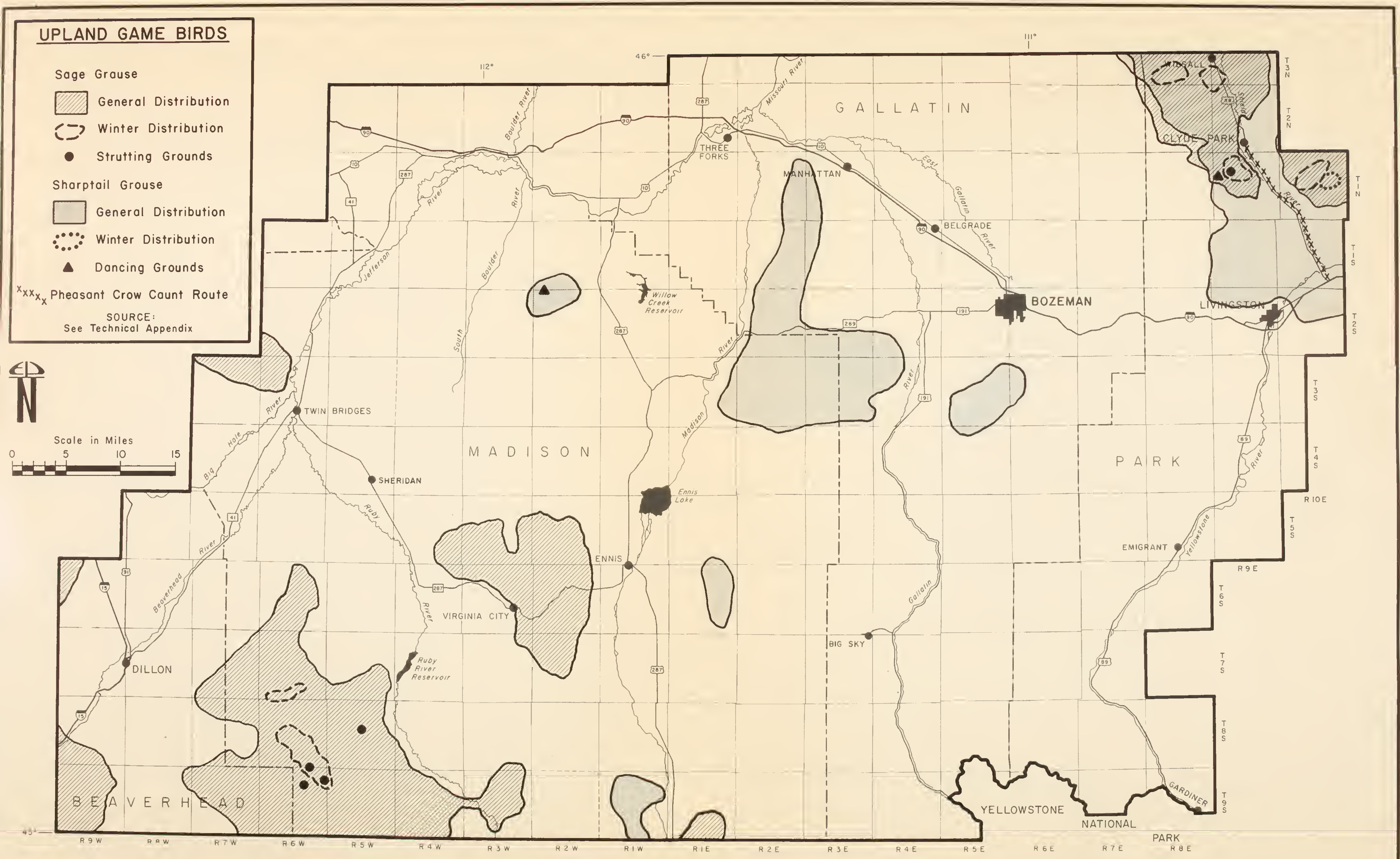
The study area is located on the eastern edge of the Pacific Flyway, and use by migratory waterfowl is less than in many other areas of Montana. However, waterfowl populations do constitute an important hunting resource in the study area. Estimates of 1974 hunting pressure and hunter harvest of ducks and geese in counties within the study area are given in Technical Appendix I. Because of its abundance and the fact that most other species precede it in fall migration, the mallard comprises the bulk of the waterfowl harvest in the study area.

II.A.4.c. Raptors

Raptorial bird species known to occur in the study area include three accipiters, four buteos, two eagles, one harrier, one osprey, four falcons, and eight owls. All are predatory, and their abundances are largely dependent upon abundances of preferred prey species. The reproductive potential of large raptors is generally lower than that of most other bird species; the pre-reproductive period is relatively long, and relatively few young are normally fledged each year. The numbers and distributions of raptor nesting territories are generally quite stable from year to year, and most raptor species show a strong tendency to return to traditional nesting sites year after year. The endangered peregrine falcon and the threatened prairie falcon have nested within the study area in recent years. These two species, notably the peregrine falcon, have declined drastically over much of North America due to the effects of pesticides.

II.A.4.d. Upland Game Birds

Upland game birds found in the study area include four species of grouse, the ring-necked pheasant, the chukar, the gray partridge, and the turkey. The hunting of upland game birds is a locally important fall recreational activity; hunter harvest estimates for counties within the study area, and opening weekend harvest estimates at the Dillon and Wilsall



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checking stations are given in Technical Appendix I. Blue grouse are the major upland game bird in the study area.

In spring, sage grouse and sharptail grouse congregate at traditional breeding sites in spring, referred to as strutting grounds for sage grouse and dancing grounds for sharptail grouse. Breeding sites, as well as the general and winter distributions of these two species, are shown on the map entitled "Upland Game Birds." Disturbance of strutting or dancing grounds during the breeding season may result in their abandonment.

II.A.4.e. Other Birds

A wide variety of shorebirds and songbirds are found within the study area. Many are migratory and pass in large numbers through the intermountain valleys in spring and fall. The recreational and aesthetic value of these species is often overlooked, yet their observation contributes immeasurably to the quality of most outdoor recreational experiences. They are also of great importance in the regulation of insect numbers and as food sources for predators.

II.A.5. Mammals

The study area supports a diverse mammalian fauna; 73 species are regularly found within its boundaries, and an additional 7 species from nearby areas may possibly occur. Inventory data for mammals of known or hypothetical occurrence within the study area are summarized here and in Table 6-9. More detailed information is given in Technical Appendix I. Figure 6-8 shows times of biological activity at selected seasonal use areas in the study area.

II.A.5.a. Furbearers

Mammals classified as fur-bearing mammals by the Montana Department of Fish and Game include the beaver, muskrat, marten, mink, and river otter; several other species, although not formally classified, also contribute substantially to the fur harvest. More detailed information on certain furbearers is presented in Technical Appendix I.

The trapping of furbearers is an important recreational activity in the study area, and provides pelts with a value estimated at over $150,000 annually. Fur harvest data for Region 3, 1971-1974, is summarized in Technical Appendix I. Region 3 includes all of Beaverhead, Silver Bow, Madison, Gallatin, and Park Counties, as well as most of Deer Lodge, Jefferson, and Broadwater Counties. More muskrat are taken in Region 3 than any other furbearer, although the total values of the recent red fox, beaver, and coyote pelt harvest in Region 3 are each greater than that of the muskrat. The red fox has recently replaced the beaver as the most valuable furbearer in Region 3. The marten, wolverine, and lynx, which provide a small percentage of the fur harvest, are classified as status undetermined mammals by the USBSF&W (1973).

Table 6-9 Summary of inventory data for mammals of known or hypothetical occurrence in the Dillon-Clyde Park study area

Species1/	Preferred Habitat	Distribution within the Study Area	Major food sources	Faunal Unit2/	Classif., Status3/	Habits4/	Remarks	Sources5/
Masked shrew (Sorex cinereus)	Coniferous forests, brush, grasslands	Widespread	Arthropods, annelids, molluscs, small mammals, vegetation	M	N	T		
*Preble's shrew (Sorex preblei)	Sagebrush-grassland, coniferous forests	Unknown	Invertebrates	B	N	T	Known from near Butte, Silver Bow Co.; may range into Beaverhead Co.	
Vagrant shrew (Sorex vagrans)	Forest streambanks, grassland, marshes	Widespread	Invertebrates, small mammals, vegetation	M	N	T		
*Dwarf shrew (Sorex nanus)	Rocky areas in tundra, subalpine and montane coniferous forests	Unknown	Invertebrates	M	N	T	Known from the Beartooth Plateau; may occur in high mountains in the study area	
Northern water shrew (Sorex palustris)	Edges of mountain streams and ponds	Widespread	Aquatic invertebrates	M	N	A		Conway 1952
Little brown myotis (Myotis lucifugus)	Caves and crevices near timber	Widespread	Flying insects	W	N	VCHM	Most common and widely distributed of the bats of southwestern Montana. Most leave the study area by late fall.	Barbour and Davis 1969
Yuma myotis (Myotis yumanensis)	Caves or buildings in open areas near water	Unknown	Flying insects	S	N	VCH	Rare; usually found in mixed colonies with little brown myotis	Barbour and Davis 1969
Long-eared myotis (Myotis evotis)	Trees and buildings in open forests, arid grassland	Known only from Lewis and Clark Caverns	Flying insects	M	N	VH	Rare	Barbour and Davis 1969
Fringed myotis (Myotis thysanoides)	Caves, buildings, crevices (usu. 4000-7000 ft)	Known only from Lewis and Clark Caverns	Flying insects	S	N	VCH	Rare; reaches the northern edge of its distribution in the study area	Barbour and Davis 1969
Long-legged bat (Myotis volans)	Trees, caves, cliffs at high elevations	Unknown	Flying insects	M	N	VCH	No specific records for area but range includes all of southwestern Montana	Barbour and Davis 1969

Table 6-9 (continued)

Species1/	Preferred Habitat	Distribution within the Study Area	Major food sources	Faunal Unit2/	Classif. Status3/	Habits4/	Remarks	Sources5/
*California bat (Myotis californicus)	Crevices, caves, trees in open arid to semi-arid regions	Unknown	Flying insects	S	N	VH	Known in Montana only from Ravalli Co., may range into the study area	Barbour and Davis 1969
Small-footed myotis (Myotis subulatus)	Near forests at relatively low elevations	Unknown	Flies, beetles, ants	W	N	VH	No specific records for study area but probable range includes all of southwestern Montana	Barbour and Davis 1969
Silver-haired bat (Lasionycteris noctivagans)	Restricted to coniferous forests during breeding season	Widespread; has been collected in the Bridger Mts.	Flying insects	W	N	VCMH		Barbour and Davis 1969
Big brown bat (Eptesicus fuscus)	Caves, buildings, hollow trees	Widespread but uncommon	Flying insects (primarily beetles)	W	N	VH		Barbour and Davis 1969
Hoary bat (Lasiurus cinereus)	Woodlands; roosts in trees and shrubs	Unknown	Flying insects (Primarily mosquitoes, moths)	W	N	VMH	Resident only during summer; most common while flying through valleys during migration	Barbour and Davis 1969
*Spotted bat (Euderma maculatum)	Arid areas	Unknown	Flying insects	S	NE	VH	Very rare; known in Montana only from Yellowstone Co.	Barbour and Davis 1969
Western big-eared bat (Plecotus townsendii)	Caves, mines, buildings, scrub, junipers	Widespread; known from Lewis & Clark Caverns, Jack Creek near Ennis	Flying insects (primarily butterflies and moths)	M	N	VCH	Large numbers overwinter in Lewis & Clark Caverns	Barbour and Davis 1969
Pika (Ochotona princeps)	High elevation rocky areas where rock size is large enough to provide shelter	Tobacco Root, Gallatin, Madison, Absaroka Mts. Absent from Bridger Mts.	Grasses and forbs; food stored as "haystacks" within the rocks	M	N	TC		Heath 1973
Pygmy rabbit (Sylvilagus idahoensis)	Sagebrush semi-deserts	Known from Bannack, Donovan, Dell, and near Dillon	Sagebrush	B	N	F	This Great Basin species is found in Montana only in arid sagebrush areas of Beaverhead Co.	
Mountain cottontail (Sylvilagus nuttallii)	Shrubbery, forest edges, sagebrush, grassland	Widespread	Juniper, sagebrush, grasses	M	N	T	Abundant in the sagebrush areas of Beaverhead Co.	
Desert cottontail (Sylvilagus audobonii)	Sagebrush, prairies, grasslands, junipers	Found only in the NE corner of the study area	Grasses, leaves, fruits	S	N	T		
Snowshoe hare (Lepus americanus)	Dense cover in coniferous forests to timberline; riparian thickets	Widespread	Forbs (summer); twigs, buds, bark (winter)	M	N	T	Populations undergo dramatic 10-11 year cycles, reflected by populations of lynx	
White-tailed jackrabbit (Lepus townsendi)	Grassland, sagebrush, alpine tundra	Widespread	Grasses, forbs (summer); buds, twigs, bark (winter)	P	N	T		

Table 6-9 (continued)

Species1/	Preferred Habitat	Distribution within the Study Area	Major food sources	Faunal Unit2/	Classif. Status3/	Habits4/	Remarks	Sources5/
Black-tailed jackrabbit (Lepus californicus)	Sagebrush semi-deserts	Known from Sage Cr., Dell, Bannack and near Dillon	Forbs, shrubs	S	N	T	Found in Montana only in the arid sagebrush semi-deserts of SW Montana, where it is sympatric with the white-tailed jackrabbit	
Least chipmunk (Eutamias minimus)	Sagebrush semi-deserts, coniferous forests, brushy grasslands	Widespread	Vegetation, seeds, nuts, fruits, meat, insects	B	N	TRH	Local habitat preferences seem to depend upon the presence or absence of other chipmunk spp.	
Yellow pine chipmunk (Eutamias amoenus)	Ponderosa pine and Douglas fir forests, grassland or tundra	Widespread	Seeds, fruits, insects, leaves, flowers	M	N	TRFH	The most common chipmunk in southwestern Montana	Beg 1969
Red-tailed chipmunk (Eutamias ruficaudus)	Edges and openings of Douglas fir and subalpine forests	Known from near Pipestone Pass and Little Pipestone Cr.	Seeds, fruits, leaves, flowers	M	N	T	Segregated by habitat from the yellow pine chipmunk where the ranges of the two overlap	Beg 1969;. Russell and Anderson 1956
*Uinta chipmunk (Eutamias umbrinus)	High-elevation coniferous forests	Unknown	Seeds, fruits, leaves, flowers	M	N	T	Known from the Beartooth and Absaroka Mts.; may be found in high mountains of the study area	
Yellow-bellied marmot (Marmota flaviventris)	Large rocks or rocky escarpments at all elevations	Widespread	Grasses, forbs, insects	M	N	FH	Estivates in late June; hibernates August-March	
*Hoary marmot (Marmota caligata)	Rocky areas, talus slopes near or above timberline	Unknown	Saxifrages, grasses, stonecrop, berries, roots	M	N	FH	Known from the Anaconda-Pintlar Mountains; may occur in the Tobacco Root Mountains.	
*Townsend's ground squirrel (Spermophilus townsendi)	Dry, sandy sagebrush valleys, juniper ridges	Unknown	Seeds, green vegetation	B	N	FCH	Found in the Great Basin and Snake River Plains; may extend into arid portions of Beaverhead Co.	
Richardson's ground squirrel (Spermophilus richardsonii)	Grassland, sagebrush, pastures	Widespread	Green vegetation, flowers, fruits, bulbs, insects	B	N	FCH	Two karyologically distinct subspecies occur, hybridizing along a narrow zone of contact between the Madison and Elkhorn Mts.	Nadler et al. 1971
Uinta ground squirrel (Spermophilus armatus)	Forest edges, subalpine meadows	Probably found in Tobacco Root, Madison, Gallatin Mts.	Green vegetation, flowers, fruits, bulbs, insects	M	N	FCH	Found in Montana only in the southwestern portion of the state	
Columbian ground squirrel (Spermophilus columbianus)	Valleys, forest edges, open woodlands, alpine tundra, montane meadows	Found only in the NW corner of study area	Green vegetation, flowers, fruits, bulbs, insects	M	N	FCH	Allopatric with S. richardsonii south to Three Forks; sympatric west of Three Forks	
Golden-mantled ground squirrel (Spermophilus lateralis)	Montane and subalpine forests, rubble slopes, alpine tundra	Widespread in major mountain ranges	Seeds, fruit, eggs, bulbs, mushrooms, forbs, berries	M	N	FH		

Table 6-9 (continued)

Species1/	Preferred Habitat	Distribution within the Study Area	Major food sources	Faunal Unit2/	Classif. Status3/	Habits4/	Remarks	Sources5/
Black-tailed prairie dog (*Cynomys ludovicianus*)	Grassland, sagebrush	Towns known near Sappington, Logan, Amsterdam	Grasses, insects	P	N	FC	Formerly abundant, but has nearly been exterminated from the study area. Shooting and habitat destruction are continuing	Flath 1975
Red squirrel (*Tamiasciurus hudsonicus*)	Coniferous forests	Widespread	Seeds, nuts, conifer cones, fungi, eggs, berries, insects	M	N	R		
Northern flying squirrel (*Glaucomys sabrinus*)	Coniferous and riparian forests; nests in snags	Unknown	Fungi, conifer nuts, berries, buds, insects, meat	M	N	RV		
Northern pocket gopher (*Thomomys talpoides*)	Arid sagebrush, grassland, wet meadows, open forest. Requires deep, loose soil	Widespread	Roots (esp. mountain dandelion), corms, bulbs, rhizomes, grass	M	N	F	The subspecies *T. t. idahoensis*, which may be a full species, is allopatric with *T. t. fuscus* and is found in Mont. only near Dillon	Tryon 1947; Branson and Payne 1958; Haglund 1972
Great Basin pocket mouse (*Perognathus parvus*)	Sagebrush semi-desert with friable soil	Known only in the vicinity of Dillon	Seeds of wild mustard, dock, pigweed	B	N	FH	Extends into Montana only in Beaverhead Co. near Dillon	
Beaver (*Castor canadensis*)	Along lakes, ponds, rivers, streams at low to mid elevations	Widespread	Bark and twigs of willow, aspen, alder, birch, cottonwood	W	F	A	See Technical Appendix	Townsend 1953; Casagranda 1955
Deer mouse (*Peromyscus maniculatus*)	Sagebrush semi-deserts to subalpine forests and tundra; more common in rocky areas	Widespread	Seeds, nuts, insects, fruits	W	N	F	Probably the most abundant and widely distributed wild mammal in the study area	Stoecker 1967; Haglund 1972
Northern grasshopper mouse (*Onychomys leucogaster*)	Open grassland; sagebrush semi-deserts	Known only from the vicinity of Bozeman	Insects (primarily grasshoppers), seeds	S	N	T		
Bushy-tailed woodrat (*Neotoma cinerea*)	Rimrock, rockslides, caves, buildings, talus slopes, outcrops	Widespread	Vegetation, twigs, shoots	M	N	T		
Red-backed vole (*Clethrionomys gapperi*)	Montane and subalpine forests, krummholz, tundra, aspen groves	Widespread	Green vegetation, seeds, insects	M	N	F	Numbers of this and the following vole species fluctuate widely	Stoecker 1967
Montane heather vole (*Phenacomys intermedius*)	High elevation coniferous forests, tundra with sclerophyllous shrubs	Major mountain ranges	Beargrass, lousewort, huckleberry leaves	M	N	T	In Hodgson's (1970) study, only 2 were taken, both near Hyalite Pk.	Hodgson 1970
Meadow vole (*Microtus pennsylvanicus*)	Moist grassland with herbaceous canopy cover of 85% or more	Widespread	Grass, sedges, seeds, bark, insects	M	N	F	This and/or the following species were found in all of 112 coyote scats, 226 hawk pellets, and 115 owl pellets analyzed by Haight (1937)	Hodgson 1970; Stoecker 1967; Douglass 1973; Haight 1937
Montane vole (*Microtus montanus*)	Drier grassland, sagebrush, riparian willows, tundra	Widespread	Succulent forbs	M	N	F	Has a wider ecological tolerance than *M. pennsylvanicus*	Hodgson 1970; Douglass 1973

Table 6-9 (continued)

Species[1]	Preferred Habitat	Distribution within the Study Area	Major food sources	Faunal Unit[2]	Classif. Status[3]	Habits[4]	Remarks	Sources[5]
Long-tailed vole (*Microtus longicaudus*)	Sagebrush semi-deserts to subalpine forests and alpine tundra	Widespread	Grasses, bulbs, bark	M	N	F	Usually less abundant than other grassland voles	
Water vole (*Microtus richardsoni*)	Alpine and subalpine riparian communities	Little Pipestone Cr., Hyalite Cr., Tobacco Root Mts., Bridger Mts.	Glacier lilies, huckleberries, clover, potentilla	M	N	A		Russell and Anderson 1956
Prairie vole (*Microtus ochrogaster*)	Dry sagebrush-grassland	Known only from near Bozeman	Grasses, forbs	P	N	F		
Sagebrush vole (*Lagurus curtatus*)	Sagebrush semi-deserts	Rare but widespread	Sagebrush, grasses, forbs	B	N	F	A Great Basin species which has extended its range into Montana presumably by crossing Monida Pass	Hoffmann and Jones 1970
Muskrat (*Ondatra zibethicus*)	Marshes, ponds, lakes, streams at low to mid elevations	Widespread	Aquatic vegetation, clams, frogs, fish, bulbs, grasses	W	F	A	Absent from high mountains, where the water vole occupies its habitat. Only beaver and red fox exceeded value of recent Region 3 muskrat fur harvest	
House mouse (*Mus musculus*)	Near human habitation; occasionally forested areas far from houses	Widespread	Various	W	N	T		Heath 1973; Hodgson 1970
Western jumping mouse (*Zapus princeps*)	Grassy streambanks, forests, tundra	Widespread	Seeds (primarily of grasses)	M	N	TH	Hibernates	Stoecker 1967
Porcupine (*Erethizon dorsatum*)	Conifers, sagebrush, grassland, riparian woodland	Widespread	Buds, twigs, inner bark of trees, herbs	W	N	TR	Girdling by porcupines often kills commercially valuable trees	
Coyote (*Canis latrans*)	Various; includes grassland, sagebrush, forests	Widespread	Voles, rabbits, ground squirrels, insects, birds	W	P	T	A controversial predator; known to kill sheep and other domestic stock, although small mammals provide the bulk of food	Haight 1937
Wolf (*Canis lupus*)	Various	Known only from the Gravelly Mts.	Mammals, birds	W	NE	T	Nearly extinct from Montana (See text)	Cole 1971; Flath 1975
Red fox (*Vulpes fulva*)	Coniferous and deciduous forests, tundra, grassland, sagebrush	Widespread	Small mammals, birds, insects, fruit	W	N	T	Second only to beaver in value of recent Region 3 fur harvest. Has increased in Madison and Beaverhead Co. in recent years	
Black bear (*Ursus americanus*)	See text	See text	See text	W	G	T	See text	See Technical Appendix
Grizzly bear (*Ursus arctos*)	See text	See text	See text	W	GT	T	See text	See Technical Appendix
Raccoon (*Procyon lotor*)	Riparian woodlands	Widespread	Various; includes fruit, nuts, grain, insects, frogs, eggs	W	N	TR	Have only recently expanded range into southwestern Montana	

Table 6-9 (continued)

Species1/	Preferred Habitat	Distribution within the Study Area	Major food sources	Faunal Unit2/	Classif. Status3/	Habits4/	Remarks	Sources5/
Marten (*Martes americana*)	Old-growth coniferous forests	Madison, Gallatin, Gravelly, and Tobacco Root Mts.	Small mammals (esp. voles, squirrels), birds	M	FU	TR	Rare within the study area	Newby & Hawley 1956; Weckwerth & Hawley 1962
Short-tailed weasel (*Mustela erminea*)	Near water in montane forests, intermontane valleys, tundra	Widespread	Small rodents, birds, fish, insects	M	P	T		
Long-tailed weasel (*Mustela frenata*)	Near water; sagebrush semideserts to forests and tundra	Widespread	Small rodents, birds	W	P	T	Most common in open situations where *M. erminea* is scarce or absent	
Mink (*Mustela vison*)	Along streams, ponds, lakes	Widespread	Fish, small mammals, birds, eggs, frogs, muskrats, crayfish	W	F	TA	Population turnover is nearly complete over a three-year period	Greer 1967; Mitchell 1961
Wolverine (*Gulo gulo*)	Remote coniferous forests, tundra	Major mountain ranges	Carrion, snowshoe hares, rodents	M	NU	T	Nearly extinct from Montana in early 1900's; have reoccupied much of former range	USDI 1974; Hornocker and Hash 1974
Badger (*Taxidea taxus*)	Sagebrush-grassland, shrublands, open forests, tundra	Widespread	Ground squirrels, mice, voles, cottontail rabbits, eggs	W	N	F		Jense 1968
Western spotted skunk (*Spilogale gracilis*)	Rocky semi-deserts	Known from the Ruby Mts., 10 mi. S of Dillon, 50 mi. S of Bozeman	Beetles, grasshoppers, rodents, small birds, eggs	B	P	T	Indigenous to the Great Basin; extends into Montana only in the extreme southern portion of the state	
Striped skunk (*Mephitis mephitis*)	Riparian woodlands, open forests, forest edges, agricultural areas, grassland	Widespread	Insects, fruits, small mammals, birds, carrion	W	P	T		
River otter (*Lutra canadensis*)	Rivers, lakes, ponds, larger streams at low to mid elevations	Widespread	Fish (esp. sculpins), Plecoptera, frogs, muskrat, beaver	W	F	A	Populations have been heavily reduced by trapping	Greer 1956
Mountain lion (*Felis concolor*)	See text	See text	Mule deer, elk	W	G	T	See text	See Technical Appendix
Lynx (*Lynx canadensis*)	Taiga	Rare but widespread	Snowshoe hare, birds, rodents	M	U	T	Populations fluctuate over a 10-11-year period following snowshoe hare population cycles	Nellis 1971
Bobcat (*Lynx rufus*)	Semi-deserts to dense forests	Widespread	Rabbits, rodents, birds	W	P	T	Have increased over much of range	Crowe 1975; Bailey 1974
Elk (*Cervus canadensis*)	See text	See text	See text	W	G	T	See text	See Technical Appendix
Mule deer (*Odocoileus hemionus*)	See text	See text	See text	W	G	T	See text	See Technical Appendix
White-tailed deer (*Odocoileus virginianus*)	See text	See text	See text	W	G	T	See text	See Technical Appendix

Table 6-9 (continued)

Species[1]	Preferred Habitat	Distribution within the Study Area	Major food sources	Faunal Unit[2]	Classif. Status[3]	Habits[4]	Remarks	Sources[5]
Moose (*Alces alces*)	See text	See text	See text	M	G	T	See text	See Technical Appendix
Pronghorn (*Antilocapra americana*)	See text	See text	See text	W	G	T	See text	See Technical Appendix
Mountain goat (*Oreamnos americanus*)	See text	See text	See text	M	G	T	See text	See Technical Appendix.
Bighorn sheep (*Ovis canadensis*)	See text	See text	See text	M	G	T	See text	See Technical Appendix

1/ Nomenclature follows Hall and Kelson (1959)

2/ B = Great Basin species; M = boreal or montane species; P = Great Plains or steppe species; S = Sonoran species; W = widespread species

3/ F = Furbearer, G = game animal, N = nongame species, P = predator (as classified by the Montana Department of Fish and Game 1974); E = endangered species, R = peripheral species, T = threatened species, U = status undetermined species (as classified by the U.S. Bureau of Sport Fisheries and Wildlife 1973).

4/ A = aquatic or semi-aquatic; C = colonial; F = fossorial (burrowing); H = hibernating; R = arboreal or partly arboreal; T = terrestrial or partly fossorial V = volant (flying).

5/ Burt and Grossenheider (1964), Hall and Kelson (1959), Hoffmann and Pattie (1968), Hoffmann, Pattie and Bell (1969), Hoffmann, Wright and Newby (1969), Ingles (1965), and MacClintock (1970) were used as sources throughout.. Additional sources of information for individual species are listed.

* Hypothetical in the study area.

II.A.5.b. Predators

Mammals classified as predators by the Montana Department of Fish and Game (1974) include the coyote, short-tailed and long-tailed weasels, striped and western spotted skunks, and the bobcat. Other important predatory animals, including the marten, lynx, and mountain lion, are classified otherwise. These mammals rely upon other animals (usually plant-eating species) as a major food source. The coyote, most controversial of the predators, may prey on sheep and other domestic stock in some areas, although the bulk of the diet consists of voles and ground squirrels.

II.A.5.c. Big Game Animals

All species of mammals classified as game animals by the Montana Department of Fish and Game (1974) are found in the study area; these are the black bear, mountain lion, elk, mule deer, white-tailed deer, moose, pronghorn, mountain goat, and mountain sheep. (The grizzly bear, although classified as a game animal, is not hunted in the study area and is discussed in the following section, "Endangered or Threatened Mammals.") Big game species have been studied much more intensively than any other group of mammals, and, consequently, much more data is available concerning their biology. Information on the habitat, distribution, major food sources, seasonal movements, reproduction, mortality, and harvest of each big game species is presented in Technical Appendix I; a brief summary follows.

(i) Black Bear. The black bear is distributed widely and in relatively small numbers throughout the timbered mountainous regions of the study area. Although not true hibernators, black bears overwinter in dens from November to April. They use a wide variety of foods: succulent grasses, sedges, forbs, carrion and small mammals are important in spring and summer; and huckleberries, whitebark pine nuts, and serviceberries are used heavily in fall. Females are capable of breeding at 2½ years of age, but most do not breed until at least 4½ years old. One to three cubs (usually two) are born in the den in late January or early February.

(ii) Mountain Lion. The mountain lion is a wide-ranging predator, primarily an inhabitant of remote mountainous areas. Its distribution in the study area is largely unknown, but resident populations probably occur in all major mountain ranges where the major prey species, deer and elk, are abundant. The mountain lion was classified as a predator in Montana until 1962, and has been managed as a game animal since 1971.

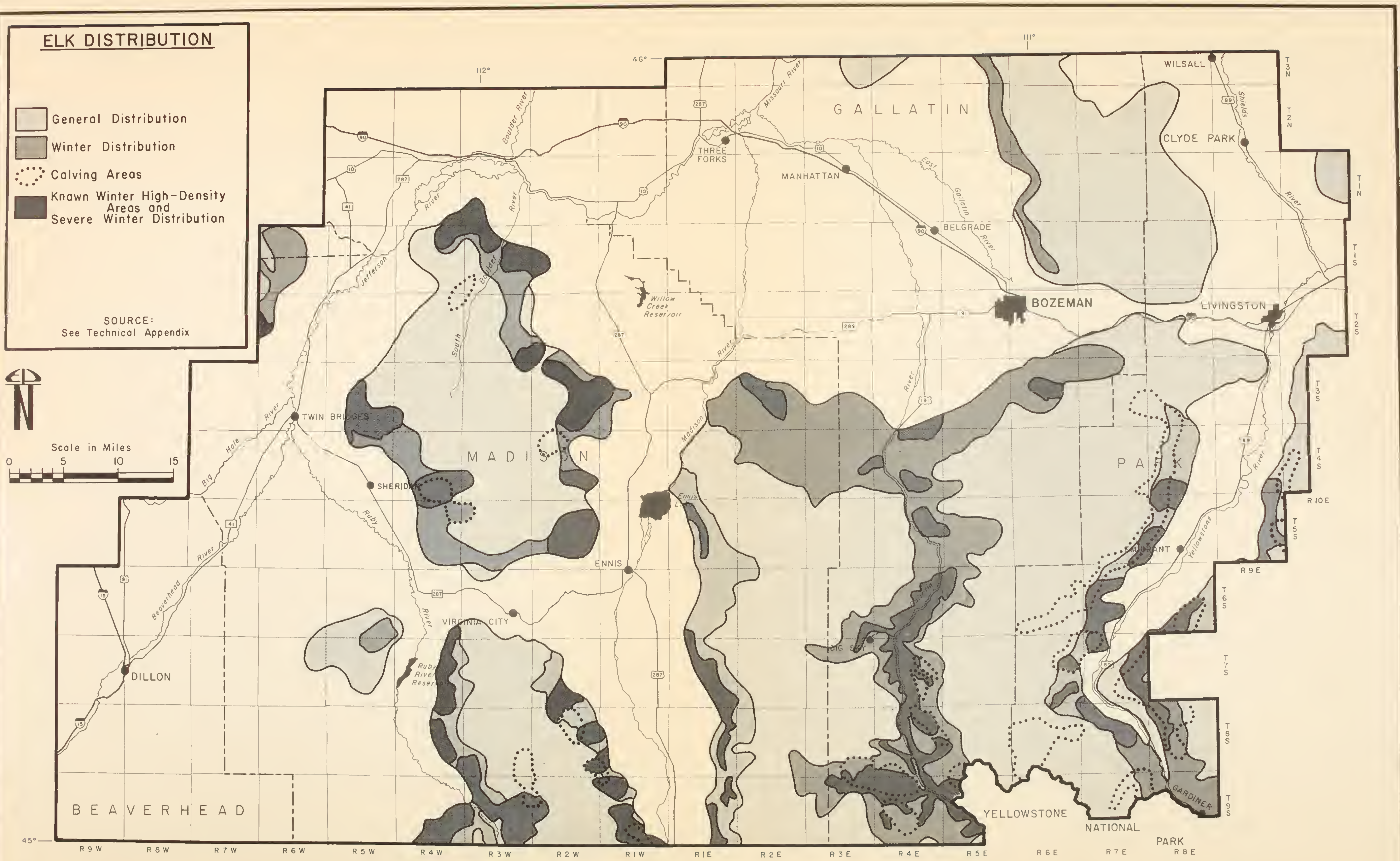
(iii) Elk. The elk is the most sought-after big game animal in the study area. Most elk in the study area are migratory; general distribution and seasonal concentration areas are shown on the elk distribution map. The summer and fall months are spent at relatively high elevations, where moist, lush forest types interspersed with grassy meadows are preferred. Forbs, grasses, and sedges are a major summer-fall food source. Movement to lower elevations begins in August, September, or October, depending upon snowfall. Winter ranges usually consist of grassy wind-blown ridges or south-facing slopes. Grasses and sedges constitute the bulk of the diet on the winter range, although browse, particularly sagebrush, becomes important during winter periods of severe cold weather and heavy snow cover. Downward movement may continue into April during unusually severe winters; severe winter distribution and known high-density areas are shown on the map entitled "Elk Distribution." Upward migration to summer-fall ranges usually begins in April, depending again upon snow depths. Calving takes place in late May and early June, generally in sagebrush areas near the upper limits of the winter range. Known calving grounds are indicated on the map entitled "Elk Distribution."

The controversial Gallatin Elk Herd summers in Yellowstone Park and winters in the study area; a detailed discussion of the migratory habits of this herd may be found in Technical Appendix I. The condition of the Gallatin Canyon elk winter range had been deteriorating until recently due to overpopulation of elk and the resultant overuse of forage plants.

There is a tendency to refer to winter range, especially severe winter ranges, as "critical" areas, partly because animals on winter range are generally more vulnerable to natural mortality than at other times of the year, and because the extent of winter range may be limiting to the population. However, it should be emphasized that yearlong habitat is critical to the population as well, insofar that its extent and condition determines the condition of the animals when they arrive at the winter range, and hence their ability to survive the winter. Similarly, the extent and condition of winter range used early in the season may be more important to elk than that of winter range used late in the season or during severe winters; forage obtained early in winter determines in part the animal's ability to "coast" through periods of severe weather and heavy snowfall (Figure 6-9).

(iv) Mule Deer. Mule deer are the most abundant big game animal in Montana, and provide a greater annual harvest than any other species. Like the elk, mule deer are primarily migratory in the study area, although resident populations are found yearlong at lower elevations. Individuals probably occur on every section of land in the study area, at least periodically. In summer and fall, mule deer are distributed widely among all vegetation types, although most are found in timber at relatively high elevations. Movement to winter ranges usually occurs following the first heavy snows of October and November. Sagebrush-grassland areas on steep south-facing exposures, especially where mountain mahogany and Rocky Mountain juniper provide cover, are used extensively in winter and spring (see map entitled "Mule Deer Winter Distribution" and Figure 6-8.) Deer normally remain on the winter range through mid-May, when upward movement into Douglas fir timber types begins. Fawns are born in May, June, and July.

Browse, especially big sagebrush, mountain mahogany, bitterbush, and Rocky Mountain juniper, is the most important forage class at all seasons except summer, when forbs assume importance. Summer and fall diets show a high variability due to the wide dispersal of deer among all vegetation types. Most winter ranges in the study area are in poor condition due to overuse, showing little signs of recovery in spite of a recent decline in deer populations.



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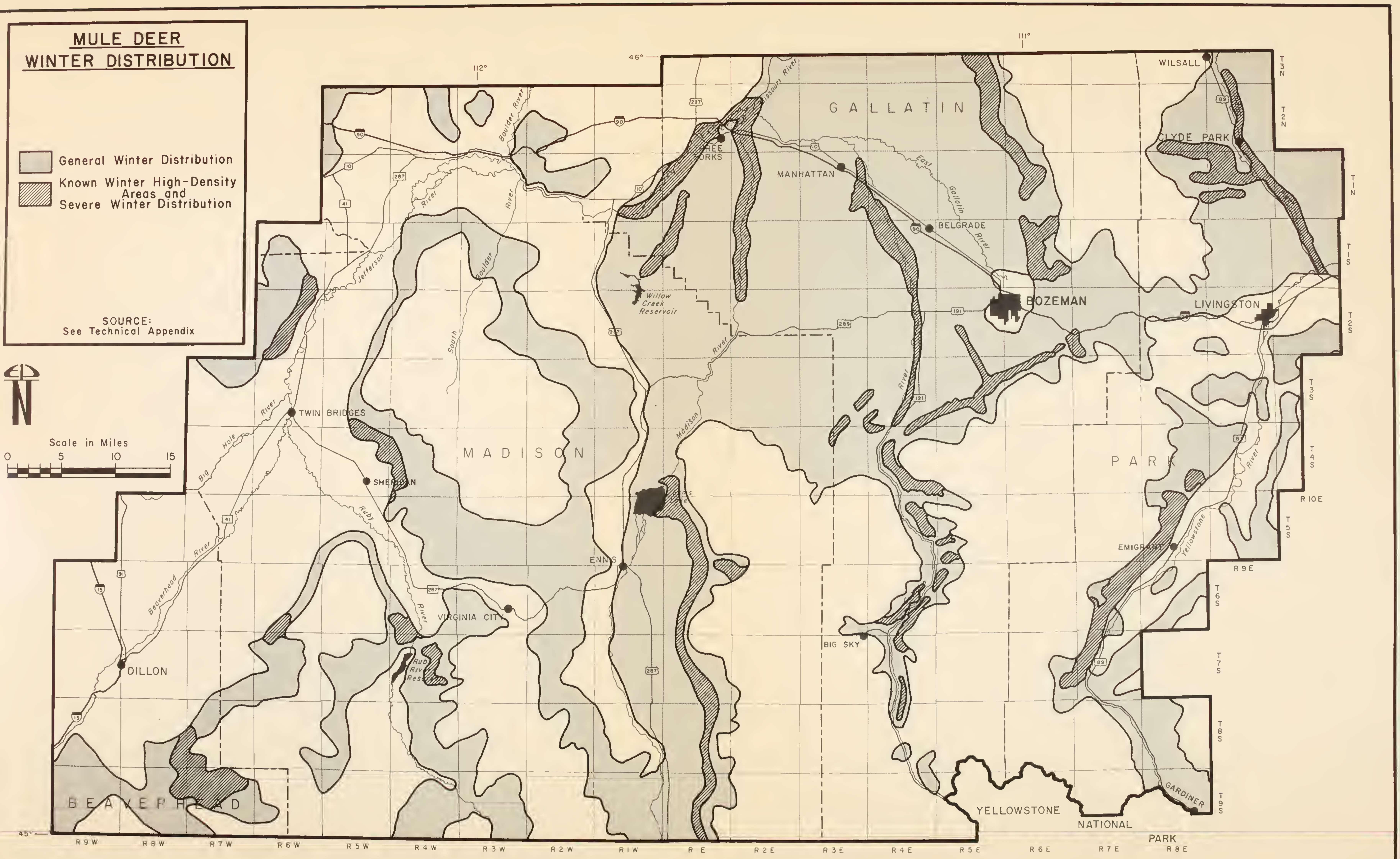

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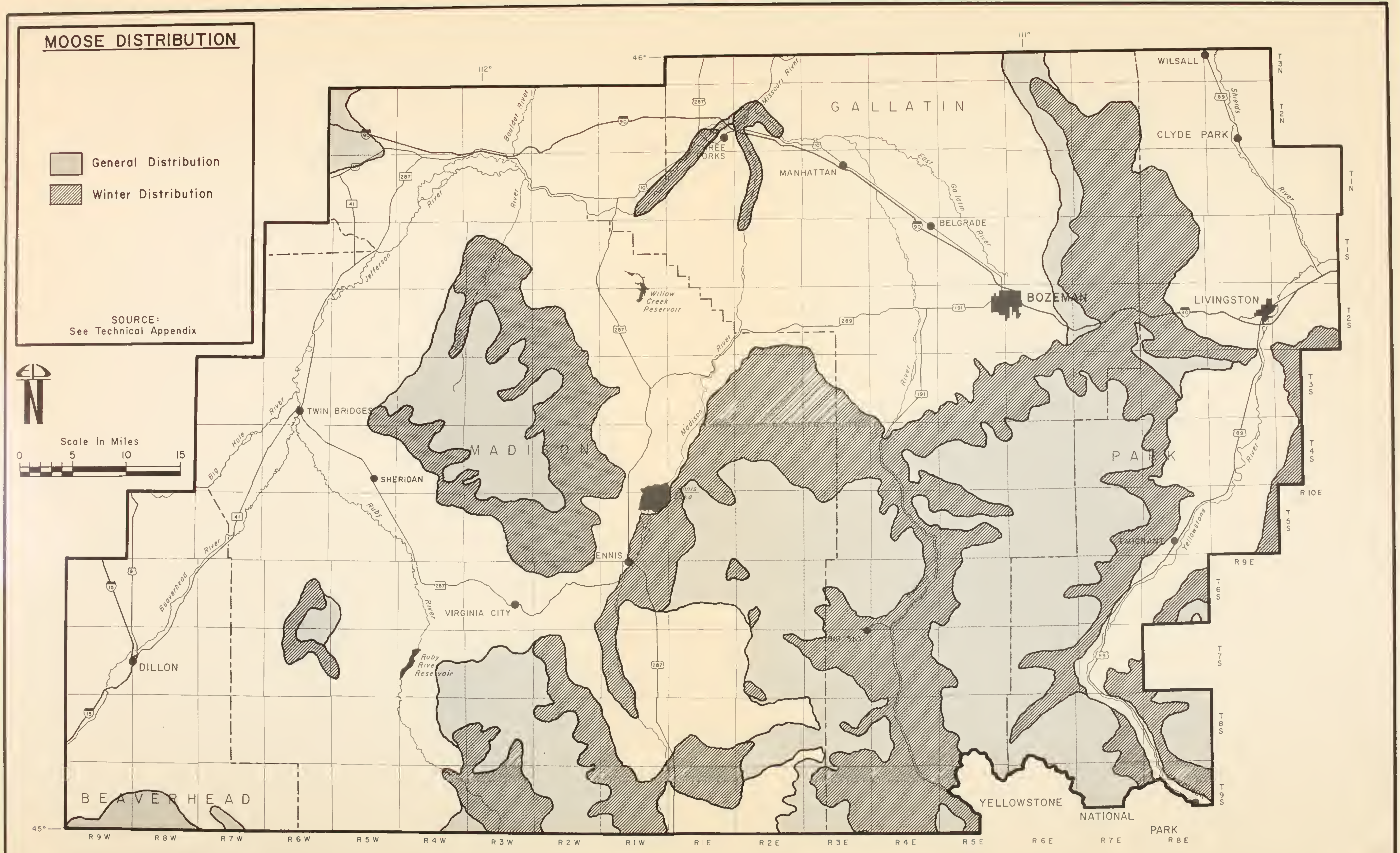

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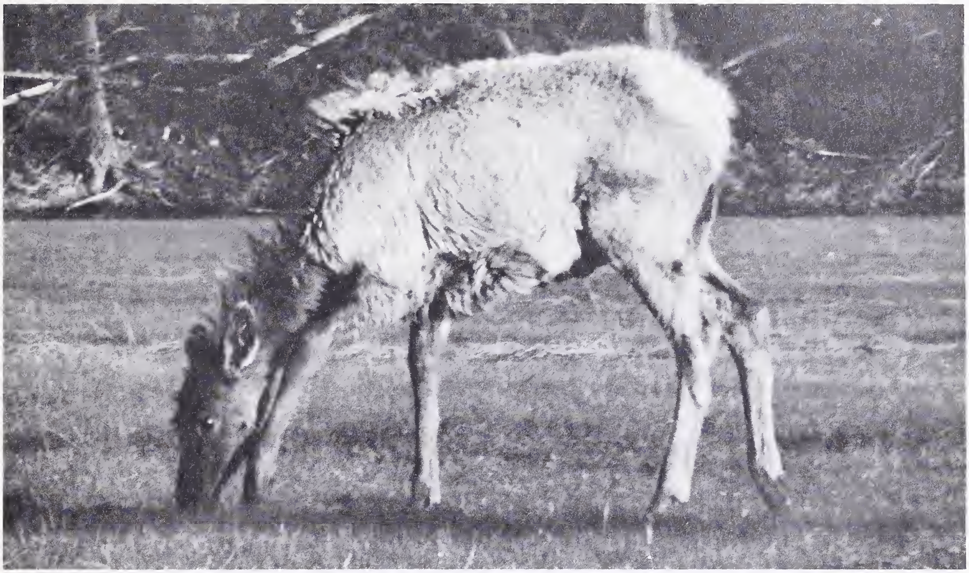


Figure 6-9. The winter months are a period of severe stress for elk and other large ungulates, and their survival through a severe winter (such as the winter of 1974-5) is largely dependent upon their condition at the beginning of winter. Any added stresses, such as those resulting from harassment or displacement into areas of deeper snow, decrease the animal's chances for survival into spring.

(v) White-Tailed Deer. The white-tailed deer is much less abundant than the mule deer, usually accounting for less than 20% of the annual deer harvest in the study area. Resident populations are found in dense deciduous forests along the major rivers of the study area. These deer are non-migratory, although some movement into alfalfa fields occurs with spring green-up. Browse, especially snowberry and cottonwood, is the most important forage class during all seasons except late spring and summer, when forbs assume importance.

(vi) Moose. The moose is the largest native mammal found in Montana. General and winter distribution within the study area is shown on the map entitled "Moose Distribution." Both migratory and resident populations occur here. High-elevation spruce-fir forests are used extensively in summer and fall; migratory moose move along drainages to lower elevation winter concentration areas (usually willow bottoms) as late winter snows accumulate on higher slopes. Moose reach their greatest densities on these wintering areas, and some moose are resident yearlong in and near willow bottoms. Upward movement occurs in spring, determined by the duration of deep snow cover.

Moose are primarily browsers; willows are an important browse species at all seasons and constitute the bulk of the winter diet. Forbs are an important component of the diet in spring and summer.

(vii) Pronghorn. The pronghorn, or antelope, typically inhabits open, rolling grassland or sagebrush-grassland areas and adjacent agricultural land. General distribution in the study area is shown in the Pronghorn and Bighorn Sheep Distribution Map. Browse, especially sagebrush, is the major food source in winter and spring, while forbs are heavily used in summer and fall.

(viii) Mountain Goat. Although not native to southwestern Montana, the mountain goat has been successfully transplanted into several mountain ranges within the study area. General and winter distribution is shown on the map entitled "Mountain Goat Distribution."

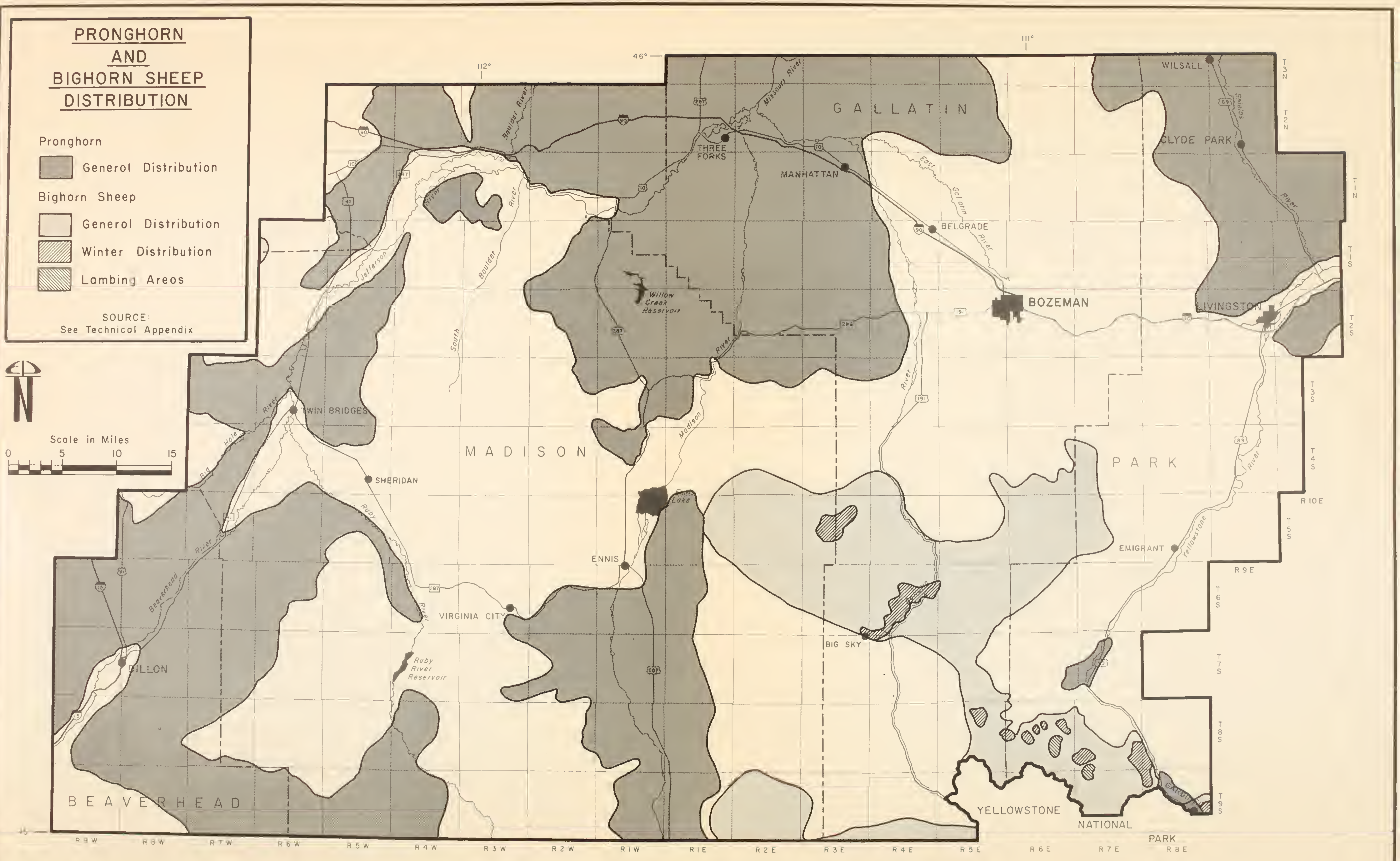
Mountain goats generally prefer steep, rugged alpine cliffs, although a small population of about 10 goats is found yearlong at relatively low elevations along Bear Trap Canyon. Movements between summer and winter ranges are not extensive, and some winter movement from deep snow areas to areas of less snow occurs. About two-thirds of the goats in the Spanish Peaks remain in the Peaks yearlong; a small segment migrates to a winter concentration area along Jack Creek. Grasses, sedges, rushes, and forbs are important forage sources year-round. Browse, especially mountain mahogany, was the most important winter forage class in both the Jack Creek area and Bear Trap Canyon; alpine fir may be an important winter food source in the Spanish Peaks.

(ix) Bighorn Sheep. Bighorn sheep are native to the Gallatin and Madison Mountain Ranges, and have been transplanted to several other sites within the study area with variable success. General distribution, winter distribution, and lambing areas of bighorn sheep in the study area are shown on the map entitled "Pronghorn and Bighorn Sheep Distribution."

Most bighorns make fairly extensive movements between summer and winter ranges. High elevation grasslands, usually above timberline, are preferred summer-fall habitat. Migration to winter ranges, usually snow-free grassland areas with nearby cliffs, occurs in September or October. Most of the West Gallatin bighorn sheep herd winters on wind-blown ridges and slopes at fairly low elevation (Figure 6-10), but a small segment winters on high ridges above 9700 feet in the Spanish Peaks. Lambs are born in May and June on cliffs within the winter range, and return to the summer range begins in June. Grasses are the most important forage class at all seasons except summer, when forbs receive heaviest use.

II.A.5.d. Endangered or Threatened Mammals

(i) Gray Wolf. The gray wolf is the only endangered mammal known to occur in the study area. Once common throughout Montana, wolves have nearly been exterminated, and only a few relict populations exist today in some of the more remote areas of the state. Reports of wolves from Yellowstone Park (Cole 1971) and the Spanish Peaks-Jack Creek area (Basile 1975) are unconfirmed,



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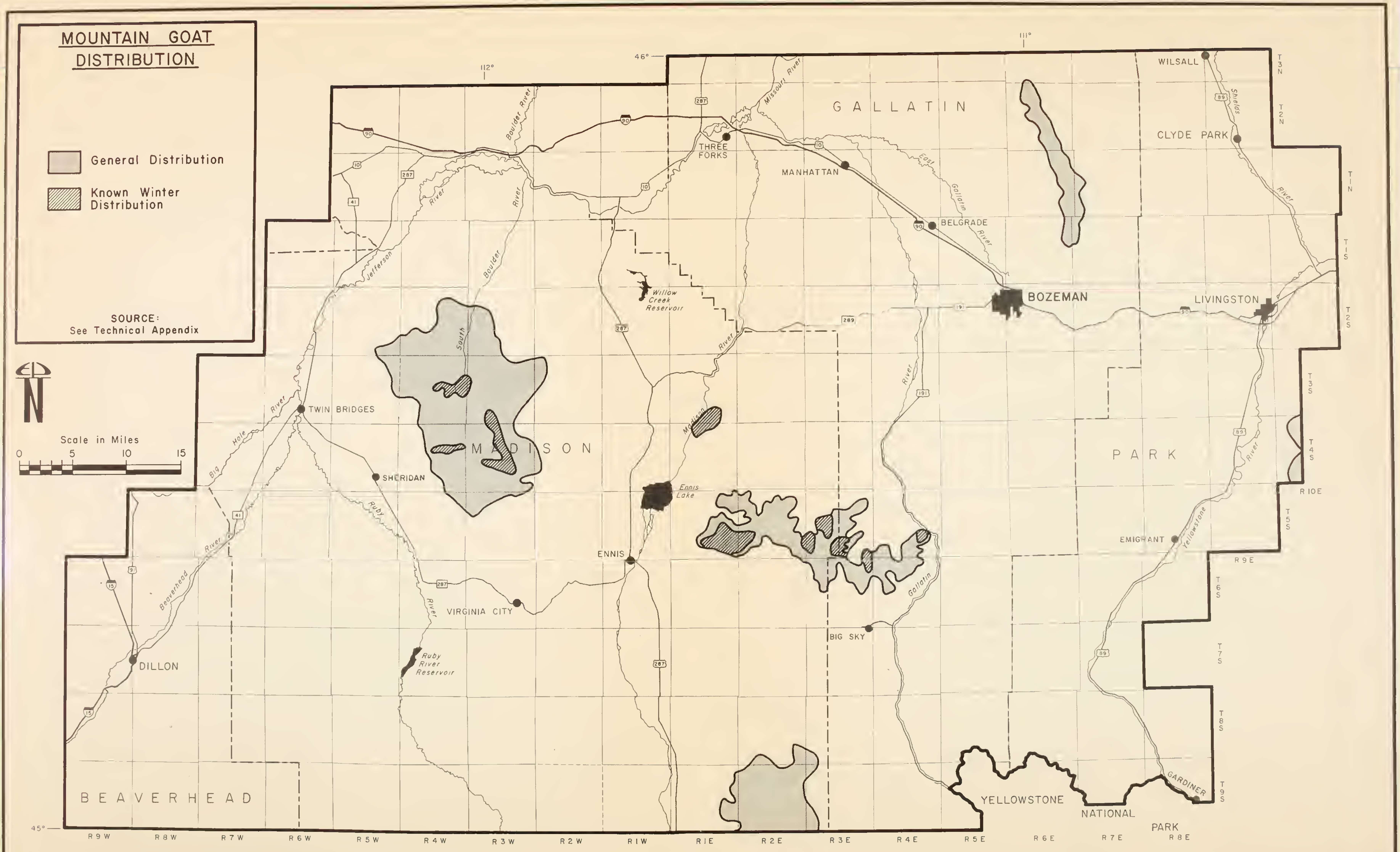

MOUNTAIN GOAT DISTRIBUTION

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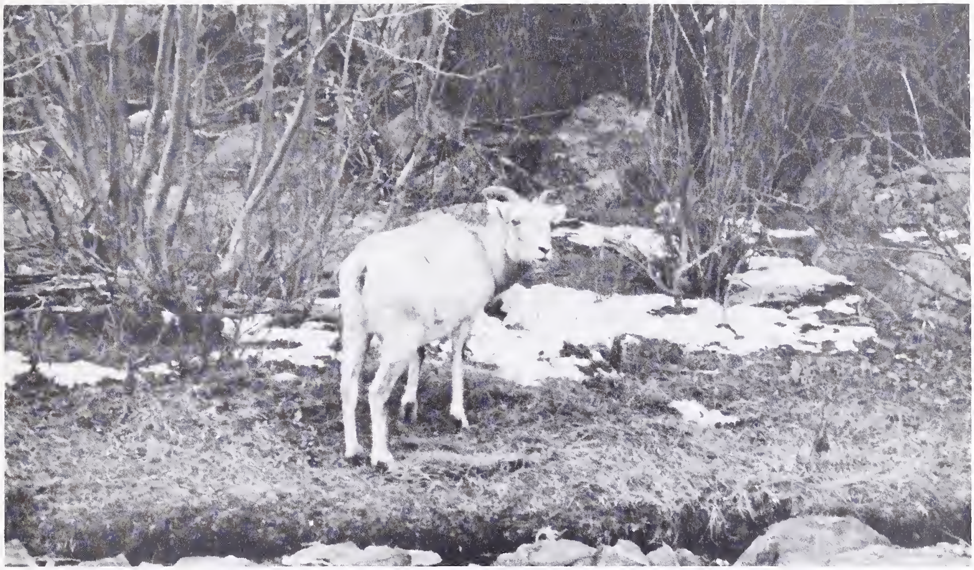


Figure 6-10. Wintering bighorn sheep have little fear of humans or predators as long as steep escape terrain is available nearby. This often brings the sheep into the proximity of roads, where they are especially vulnerable to illegal shooting or collisions with vehicles. This photograph was taken from U.S. 191 in Gallatin Canyon.

but Flath (1975) reports a population of unknown size to exist in the Gravelly Mountains near the southern edge of the study area.

Little is known of the ecology of Montana wolves. Adults in other areas subsist primarily on a diet of large ungulates (normally only old, weak, or diseased individuals) supplemented by smaller mammals and birds. Four to six pups are born in April or May following a gestation period of 60-63 days; females first breed at 2-3 years of age. Wolves are highly social and normally travel in packs of 3 to 7 individuals, usually consisting of mated pairs and their offspring. These packs may travel over 20 miles per night while hunting (Flath 1975b).

(ii) Grizzly Bear. The grizzly bear is the only threatened mammal known to occur in the study area. Of an estimated 600 to 1000 grizzly bears remaining in the contiguous United States, Yellowstone Park and adjacent national forests contain one of the largest discrete populations. Estimates of the recent size of this population range from 136 (Craighead et al. 1974) to over 500 (Knight et al. 1975). Although most are resident within Yellowstone National Park, grizzlies are known to occur in parts of the Gallatin National Forest within the study area. Confirmed sightings of grizzly bears within the study area in 1973 and 1974, as well as their probable distribution, are shown in the map entitled "Grizzly Bear Distribution."

(Numbers 1-15 on the map refer to a listing of grizzly bear sightings, found in Technical Appendix I.) Persistent reports of grizzly bears in the Tobacco Root Mountains have not been verified.

A remarkably versatile species, the grizzly bear has historically occupied a wide variety of habitats, and was once found from Mexico to the arctic. However, today grizzly bears in the contiguous United States are primarily restricted to remote, wilderness-like mountainous areas, and wander only occasionally into valleys, agricultural areas, and areas of human habitation. Within the range of the species, optimum grizzly bear habitat generally includes open sites, such as sagebrush-grassland areas, alpine and subalpine sidge-bluegrass meadows, and rockslides, in combination with heavily timbered areas. Where sympatric with the black bear, as in the study area, grizzlies tend to use only the highest elevations. Food items of the grizzly bear include a variety of vegetable matter, mammals, carrion and, in some parts of Yellowstone Park, garbage. In late summer and fall, whitebark and limber pine nuts are used extensively, as are huckleberries occurring in burned-over areas and the forest understory. Grizzly bears are not true hibernators, but enter a period of winter sleep which lasts 5-6 months (November-March).

The grizzly bear has one of the lowest reproductive rates of all land mammals. Females may breed at 4½ years of age, although many do not produce litters until 7 or 8 years old. Breeding peaks in June, and young (usually 2) are born in the den in late January or February. The reproductive interval may range from 2-7 years. Most recent mortality in the Montana portion of the Yellowstone ecosystem has been man-caused, although the hunting season in this area has been closed since 1974.

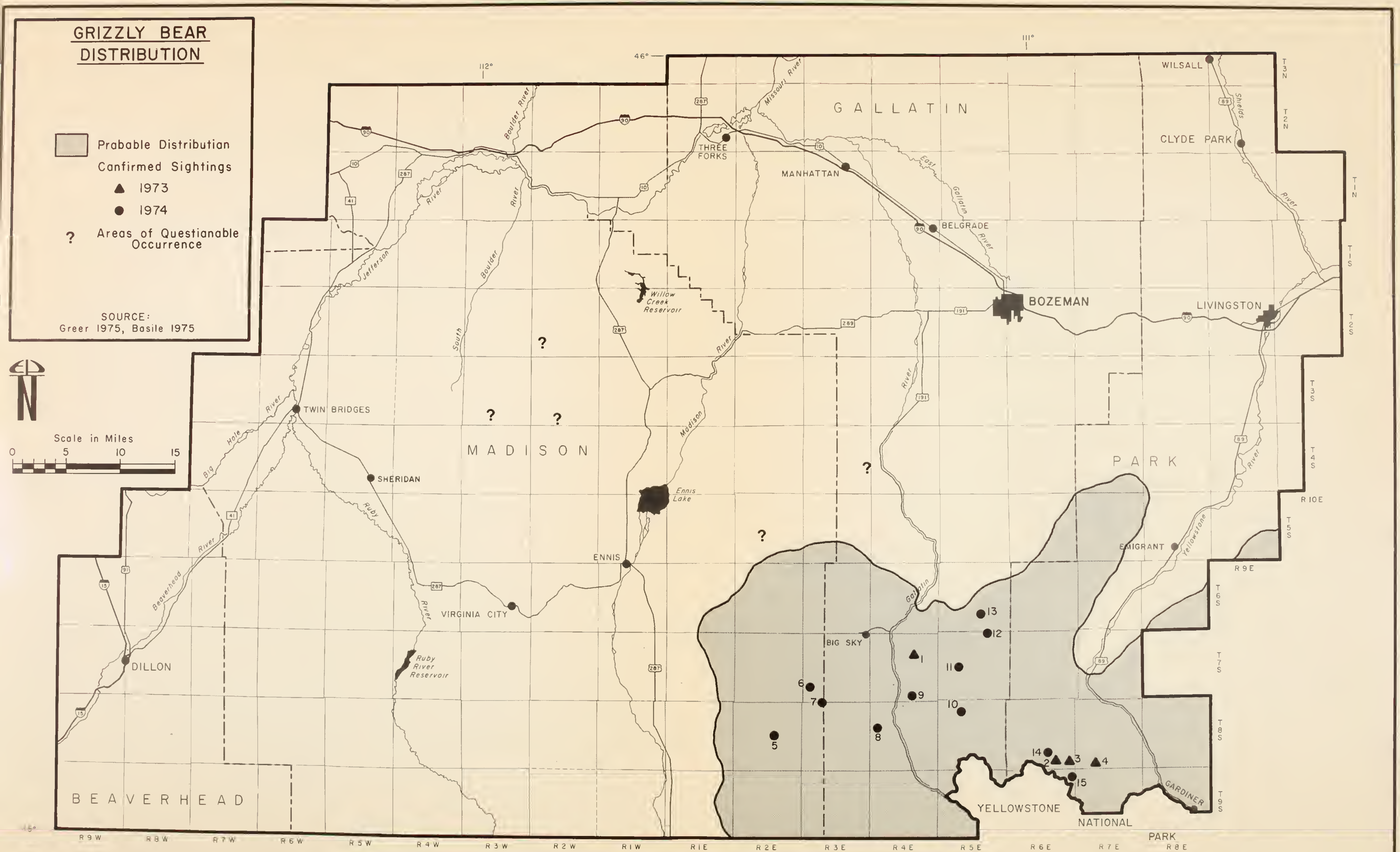
It is generally recognized that areas of human activity and development are incompatible with grizzly bears, largely because conflicts between grizzlies and humans in these areas nearly always lead to eradication of the grizzlies.

II.A.5.e. Other Mammals

Many species of other mammals (see Table 6-9) found in the study area contribute to man's enjoyment, and form a major part of many food chains. A summary of small mammal studies conducted in the study area is given in Technical Appendix I.

II.B. Parameters

Inventory data collection for fauna of the study area was limited to parameters relevant to transmission line siting and impact evaluation: 1) value, 2) vulnerability, and 3) ecology of individual species. The value parameter can be identified in three ways - resource value, recreational value, and scientific value. Vulnerability refers to species which are susceptible to extinction or population reduction as a result of environmental change. Both local and worldwide abundances of vulnerable species are discussed.



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The ecological parameter contains a discussion of the importance of habitat, species distribution, major food sources, seasonal movements, species habits, and population dynamics. These inventory parameters are discussed in more detail below.

II.B.1. Value

II.B.1.a. Resource Value

The hunting of game animals and the trapping of furbearers has a direct economic value; it results in significant expenditures for equipment, lodging, transportation, and licensing, and the harvest results in a considerable quantity of usable meat and pelts. Data on the estimated harvest of game animals and furbearers in Region 3, which includes the study area, is given in Technical Appendix I.

II.B.1.b. Recreational Value

Estimates, based upon hunter and fisherman questionnaires, of the number of hunter days or fisherman days spent in pursuit of game animals, have been furnished by the Montana Department of Fish and Game, and are presented in Technical Appendix I.

II.B.1.c. Scientific Value

Endemic species or subspecies (those which have evolved in, and which are now confined to a relatively small geographic area), and relict populations (disjunct populations which represent remnants of a former, more extensive distribution, such as the remnant populations of the gray wolf and arctic grayling in the study area), are of unusual scientific interest and merit special consideration. Also of scientific value are unusual populations, such as those of the tiger salamander found in Axolotl Lakes, which are confined or nearly confined to the study area.

II.B.2. Vulnerability

Animal species differ markedly in their ability to adapt to environmental changes brought about by human activity; some are tolerant of a great degree of disturbance, while others may be sensitive to relatively slight disturbance. An attempt is made below to identify those species which are relatively intolerant to environmental changes, or which are especially vulnerable to extinction or population reduction as a result of environmental change.

II.B.2.a. Status

The U.S. Bureau of Sport Fisheries and Wildlife (1973, 1975) has identified certain species of animals as endangered, threatened, or status undetermined, as defined below.

Endangered species are those determined by the Secretary of the Interior to be threatened by extinction; these are listed in the Federal Register and are protected under the Endangered Species Act of 1973. Two endangered species, the gray wolf and peregrine falcon, are known to occur within the study area.

Threatened species are those not listed in the Federal Register, but nevertheless threatened by extinction; they are identified in the 1973 "Red Book" (USBSF&W 1973). Threatened species found within the study area include the grizzly bear, prairie falcon, and arctic grayling.

Status-undetermined species or subspecies are those which have been suggested to be possibly threatened with extinction, but about which there is insufficient information to determine status (USBSF&W 1973). These include the lynx, wolverine, marten, ferruginous hawk, osprey, merlin, longbilled curlew, and burrowing owl.

The 1973 "Red Book" has been superseded by the Endangered Species Act of 1973, which provides for reexamination and reclassification of wildlife species as endangered or threatened, with no provision for a "status undetermined" classification. Several species listed in the 1973 Red Book, e.g., the grizzly bear, have been formally reclassified; others have not. Although the legal status of many species listed in the Red Book has changed, their biology has not; it is assumed here that species identified in the Red Book as deserving special consideration were identified for a reason, and that these reasons are still valid even though reclassification is underway. For this reason, species identified in the Red Book will be given special consideration in this study, although the Red Book classifications are no longer officially valid.

II.B.2.b. Worldwide Abundance

Species which are exceedingly rare, whether formally classified as endangered or not, are susceptible to rapid extinction if mortality rates are suddenly increased or if habitat is destroyed. Few of the species found in the study area, however, are exceedingly rare. Only the grizzly bear, bighorn sheep, trumpeter swan, and peregrine falcon have worldwide abundances which are estimated at less than 100,000 individuals.

II.B.2.c. Restriction of Distribution

The percentage of the worldwide population of a species the study area possesses is an important factor in assessing potential impacts. If the entire species is confined to a small area being considered for environmental alteration, the chance exists that the species may become extinct if the alteration proves detrimental to the population. However, if large populations of the species exist outside the area being considered, there is little chance of worldwide extinction even if the alteration proves highly detrimental and results in local or regional extinction. There are no species of vertebrates which are confined or largely confined to the study area.

II.B.2.d. Reproductive Potential

Populations of animals having a low reproductive potential are relatively slow to recover from population losses, and may not be able to compensate for heavy and continued mortality. If populations are small, these species are highly vulnerable to local or regional extinction. The trumpeter swan, which has one of the lowest reproductive potentials of all birds, once approached extinction as a result of a man-caused increase in mortality rates. Other species found within the study area which have an exceptionally low reproductive potential include the black bear, grizzly bear, marten, wolverine, river otter, mountain lion, elk, moose, mountain sheep, mountain goat, and most large raptors (see Technical Appendix I).

II.B.3. Ecological Parameters

II.B.3.a. Habitat

The habitat of an animal species may be defined as a type of area having environmental conditions which support or which could potentially support natural populations of the species. Generally, the habitats used by a given species are characterized by a certain vegetation type, such as sagebrush or coniferous forest, and/or by certain physiographic features, such as lakes or steep cliffs. As mentioned above, species differ considerably in habitat specificity, some being narrowly restricted to a particular seral stage, elevation, or section of stream, and others ranging freely through a wide variety of vegetation types, elevations, and stream systems. Also, the habitat preference of many species shifts seasonally, as illustrated in the case of migratory birds or spawning fish.

Although a given species may have the capability to exist in a variety of widely different habitats, it may prefer certain habitats over others and be found in greatest abundance in those preferred habitats. In the inventory tables (6-5, 6-6, 6-7, 6-8, and 6-9) the preferred habitat of each species is listed; that is, those vegetative and physiographic types found in the study area in which self-sustaining populations may reasonably be expected to occur.

The importance of the maintenance of suitable habitat for the well-being of animal populations is obvious. If an area of preferred habitat is altered in such a way that it no longer fulfills the requirements of the species, population levels in the affected area can be expected to decline.

The carrying capacity of the environment (the optimum number of individuals which the environment can maintain over a long period of time) is largely a function of habitat quality; larger populations can be maintained in areas of optimum habitat than in areas of marginal habitat. The loss or degradation of an area of preferred habitat of a species may be equivalent to a reduction in the carrying capacity of the environment with respect to that species.

II.B.3.b. Distribution

Several species, primarily game species, have been studied in sufficient detail to allow the delineation of general and/or seasonal distribution. The general distribution of a species is defined as that area in which individuals occur regularly during at least part of the year. It should be realized that the boundaries of the general distribution of a species are not absolute; individuals may occasionally wander far from their usual range. Boundaries represent, rather, lines of probability enclosing areas of high likelihood that individuals of a particular species may be found. In certain cases, known areas of concentration or seasonal use areas are also delineated within the general geographic distribution.

Populations of a given species do not always occur in all areas of preferred habitat within the geographic range of that species, either because of local extinction or an inability to colonize. For this reason, it is desirable from the standpoint of corridor selection and impacts evaluation to know which stands of habitat within the study area support populations of a given species, or, in other words, to delineate the actual distribution of populations of that species.

In the case of those species whose general distribution is not mapped, a verbal or symbolic description of distribution within the study area is given in the inventory tables. In these tables, the word "widespread' indicates that individuals may reasonably be expected to occur in most areas of preferred habitat within the study area. Where known distribution is limited to a portion of the study area or to a few isolated sites, it is so described.

II.B.3.c. Major Food Sources

Environmental changes resulting from transmission line construction and operation may alter the availability or production of food for certain species. Thus, it is desirable to know what items constitute the bulk of the diets of animals found within the study area in order to assess possible impacts. Major food sources are listed in the inventory tables, and quantitative data on seasonal food habits of certain game animals are presented in the Technical Appendix. Animals are consumers and rely (directly or indirectly) upon the primary production of plants to supply metabolic and structural needs; hence, impacts upon animal populations are closely linked to impacts upon vegetation.

II.B.3.d. Seasonal Movements

Many species travel relatively long distances in response to seasonal changes in food abundance and availability or habitat condition. For example, migratory birds may travel hundreds or thousands of miles between well-defined summer and winter ranges. A large number of birds, notably waterfowl species, pass through the study area during migration, but neither breed nor winter there.

Areas of seasonal concentration or seasonal reproductive activity are often referred to as "critical areas." However, use of this term is avoided because of the implication that other segments of habitat are not critical. All areas of habitat used by a population are critical to that population at the appropriate place and time, and although many big game populations may be limited by winter range, the extent and condition of summer habitat is equally integral to their survival.

II.B.3.e. Habits

The habits of animals have bearing upon their susceptibility to the impacts associated with transmission line construction and operation. For example, burrowing species may be unable to escape the impacts of road construction, and colonial species may be more susceptible than widely dispersed species to population reduction as a result of habitat alteration along a narrow corridor. Information on certain habits of terrestrial vertebrates is presented in this section and in the inventory tables.

II.B.3.f. Population Dynamics

An understanding of the dynamics of animal populations is necessary in order to properly assess impacts. In general, population size at any given time is determined by birth rates and death rates. If death rates exceed birth rates for a large number of generations, the population will decrease to extinction. However, if birth rates exceed death rates for a long period, the population will increase beyond the carrying capacity of the environment. Increases in mortality are usually compensated for by increases in birth rate, and increases in birth rate generally result in higher natural mortality rates. The consequence of this natural regulation of populations is that in stable, undisturbed ecosystems animal populations fluctuate above and below carrying capacity.

The breeding calendar of most species generally follows the natural progression of seasons, with breeding restricted to a certain time of year and birth occurring at a certain time of year. The vulnerability to mortality of parents or young may be greater at certain times of the reproductive cycle than at others; hence, knowledge of the timing of reproduction is essential in order to minimize potential impacts.

The reproductive potential of a species is a measure of the number of offspring which can be produced in a given period of time. Species with a long pre-reproductive period, a long gestation period, small number of young, and long reproductive interval have a lower reproductive potential than species with a short pre-reproductive period, short gestation period, large number of young, and short reproductive interval. Populations of species having a high reproductive potential can recover rapidly even from severe mortality. A much longer time is required for populations of species having a low reproductive potential to recover following an episode of high mortality.

Information on pre-reproductive period, gestation period, number of young, and reproductive interval has been compiled for certain taxa and is presented in the Technical Appendix I.

Certain types of impacts which may not result directly in the mortality of animals may increase stress levels, predisposing the animals to mortality by other causes (a discussion of stress is presented later in this section).

III. Impacts

III.A. Introduction

The response of an animal or group of animals to a given environment change is often impossible to predict. This is due to the complex array of variables influencing the behavior and habitat preferences of animals, including weather, seasonal changes in hormone levels, learning, habituation, tradition, genetic differences, individual preferences, inter- and intraspecific interactions, and many others.

Consequently, no attempt will be made here to predict the exact nature and magnitude of biological changes resulting from transmission line construction and operation. Rather, an indication of the probability that significant impacts will occur as a result of the proposed facility is arrived at by a consideration of documented biotic changes resulting from environmental changes similar to those associated with the construction and operation of transmission lines.

III.B. Positive vs. Negative Impacts

An impact may be defined as any change brought about as a result of the proposed action. If no change results, there has been no impact. It is commonly thought that an environmental change which results in a reduction in the size of a given animal population is detrimental to that population and represents a negative impact, and that one resulting in an increase is beneficial and represents a positive impact. However, an increase in population size is not "good" *per se*, nor is a decrease "bad" *per se*. For example, a decrease in the size of a deer herd which is exceeding carrying capacity and causing deterioration of its range will, in the long run, benefit the herd. An impact may be judged positive ("good") or negative ("bad") for the population to the extent it brings about a departure from the optimum number of animals which the environment may support, or the carrying capacity of the environment.

A negative impact may be defined as an environmental change which: (1) reduces population size below the existing carrying capacity of the environment, whether by increasing mortality rates or by decreasing reproductive rates, (2) increases population size above the existing carrying capacity of the environment, or (3) reduces the existing carrying capacity of the environment, whether by habitat destruction or the reduction of food availability. Similarly, a positive impact may be defined as an environmental change which increases the existing carrying capacity of the environment.

Because of fundamental differences in the types and magnitude of expected impacts, aquatic and terrestrial ecosystems will be discussed separately.

III.C. General Impacts

In order to help insure that the construction and operation of the proposed transmission line will result in the least adverse impact upon the fauna on the study area, the fauna must be given consideration at three levels in the process of transmission line siting: (1) corridor selection, or the location of a two-mile-wide corridor within which the line will be built; (2) center-line selection, or the exact location of poles, conductors, and access roads; and (3) mitigating measures, or specification of the actual methods and timing of construction. Of these, only the first, or corridor selection, requires precise knowledge of the distribution of a species throughout the entire study area.

Many animal species found in the study area are relatively widespread in distribution, occupying a wide variety of habitats. These include wide-ranging predators, such as the coyote, mountain lion, and bald eagle, many smaller birds and mammals, such as the robin and deer mouse, and many invertebrates. If transmission line siting proves detrimental to these species, the impacts are likely to occur over much of the study area regardless of the exact location of the corridor. The same is true of fish and aquatic invertebrates; activities within a given corridor can have impacts upon aquatic ecosystems which are evident far downstream from the corridor (see Aquatic Fauna Impacts later in this section), and which are largely independent of corridor location.

Impacts to widespread species cannot be used specifically to choose one two-mile wide corridor over another. Proper center-line location, strict adherence to mitigating measures, and careful monitoring of construction is essential to minimize potential adverse impacts to these species.

Species which are not wide-ranging or uniformly distributed are restricted at least seasonally to certain well-defined habitats, sites, or concentration areas of limited extent. This group may be divided into: (1) site-specific species, or those whose overall distribution, seasonal use areas, or areas of high concentration are found in the same geographical area year after year and are less than 80 acres in extent, and (2) area-specific species, or those whose overall distribution, seasonal use areas, or areas of high concentration are greater than 80 acres in extent. A cut-off point of 80 acres was chosen because: (1) 80 acres was the minimum level of resolution of the overall mapping effort for this project, and (2) an 80-acre site is, in most cases, easily avoided within a two-mile wide corridor.

Site-specific species include those which are colonial yearlong, such as the prairie dog and Richardson's ground squirrel, and those which may be widespread during all or part of the year, but whose reproductive activities take place year after year on a few isolated sites. Species in the latter category include the great blue heron, double-crested cormorant, sage grouse, sharptail grouse, and most large raptors. They are especially vulnerable to local eradication, or at least curtailment of the year's reproductive effort, if disturbed during the breeding season. However, impacts to these site-specific species can be avoided or reduced by: (1) avoidance of reproductive sites by proper center-line selection within the two-mile corridor, and (2) adherence to mitigating measures, especially the restriction of construction activities to times when the sites are not occupied. Thus, it is not necessary to give these sites consideration at the corridor selection level.

Area-specific species include those which are restricted in distribution yearlong to habitats of limited extent, such as the pika, grizzly bear, water vole, and bighorn sheep; and those which are restricted seasonally to certain habitats or concentration areas of limited extent, such as the pine grosbeak, Canada goose, and wintering bighorn sheep. Certain of these may be of importance in corridor selection; however, in most cases center-line selection and mitigating measures are of primary concern.

III.C.1. Aquatic Fauna

The rivers and streams of the study area provide an effective vehicle for the funneling of impact consequences to areas far removed from an actual site of disturbance. As a result, total impact to aquatic systems is seldom limited to site-specific situations. With this in mind, the following discussion identifies the major potential impacts to aquatic systems and their sources likely to be associated with the construction of a 161-kV transmission line.

Potential major aquatic impacts include the following five categories, which are discussed separately below:

(1) Sedimentation
(2) Alteration of streamflow
(3) Organic debris
(4) Thermal
(5) Sanitary waste and toxic material

Road building and activities related to the construction phase produce the highest impact risk situation (see Figure 6-11). Impacts resulting from preconstruction, operation, and maintenance phases are expected to be minor. Most potential impact to aquatic systems is associated with sediment production and its subsequent introduction into these systems.

III.C.1.a. Sedimentation

(i) Sources of Sediment. The movement of sediment into stream systems is largely dependent on the following parameters, identified by Smith and Wischmeier (1962):

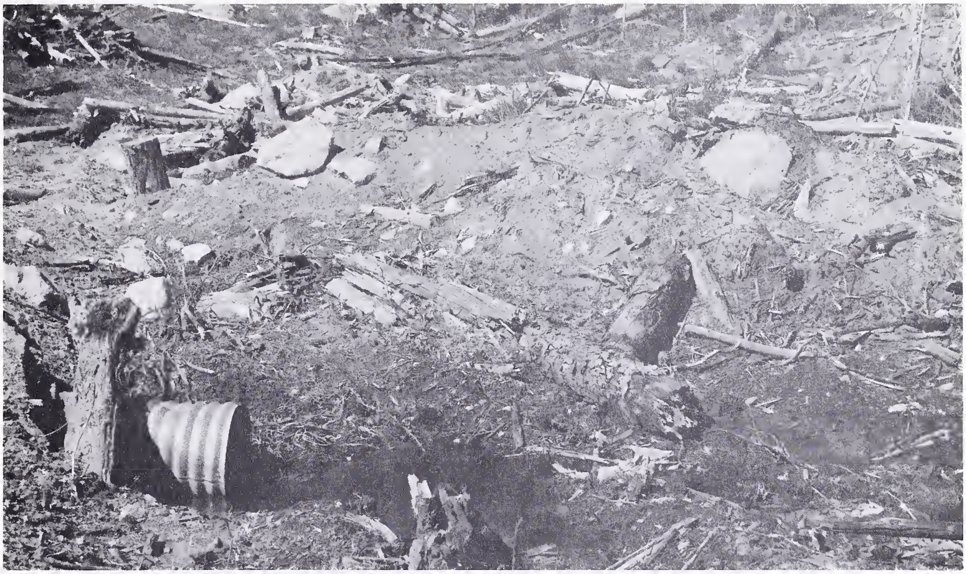


Figure 6-11. Excessive debris and sedimentation associated with road building in mountainous forested areas often has serious impacts upon the quality of water originating in these important watersheds.

(1) Characteristic rainfall of a particular area and its relation to erosion (transport of soil as influenced by the intensity of rainfall)

(2) Soil erodibility (infiltration and percolation rates of soil; also soil properties determining the ability of the soil type to resist transport)

(3) Topography (land slope, drainage, etc.)

(4) Vegetation (parameters which will directly affect the rate of nutrient loss)

In the following discussion, three activities likely to have the highest risk for sediment input, through direct disturbance of the streams themselves or an increase in erosion in unstable areas, are identified: (1) construction of access and maintenance roads, and tower site construction activities, (2) vegetation removal along right-of-way, and (3) heavy equipment movement.

The building of access and maintenance roads, particularly if they are in steep mountainous areas with unstable soils, provides a high risk for increased sediment output, and may ultimately result in the direct disturbance of a much larger area than is involved in the actual transmission line right-of-way. Soil mass movement and landslide erosion, both of which are commonly associated with road building in these areas, have been identified as a major source of sediment output and introduction into aquatic systems (Fredriksen 1972, Swanston 1970). Studies have also shown that sediment deposition in areas where no timber removal took place, but where roads were constructed, was as high as when logging followed road construction (Megahan & Kidd 1972). Kitchings et al. (1974) indicates that a similar situation would occur with the construction of transmission line access and maintenance roads.

The crossing of small streams by roads will also provide a high risk for sediment production and direct movement into the stream systems, either through the direct crossing of the stream or the inadequate placement and installation of culverts or bridges.

Clearing of vegetation from steep slopes with unstable soils or along stream channels can lead to increased erosion and sediment transport with a risk for subsequent introduction into the stream systems.

The movement to and from the construction sites by large, heavy equipment involved in the site preparation and tower erection process has been known to result in breakdown and damage to existing and new roads utilized for access. As a result, erosion is increased in areas of steep slope and unstable soils, and is compounded by road use during wet conditions. Inadequate road construction is also a primary source of road failure. The fording of small streams by vehicles and equipment while traveling in the transmission line right-of-way can cause increased sediment levels in the streams by direct disturbance of the stream bottom and breakdown of the stream banks. Ruts generated by travel in steep areas during wet conditions provide a very effective means for the channeling and rapid transport of sediment.

(ii) Impacts of Sediment Introduction into Aquatic Systems. Among the major causes of aquatic insect mortality associated with sediment introduction are: (1) its abrasive action, (2) the clogging of delicate external gill systems by suspended sediment, (3) egg mortality, and (4) the smothering of those forms that are relatively non-motile by the deposition of sediment. If the mortality is great enough to represent a major loss of the food supply to the fish present in the stream, the productivity of resident fish populations may be affected (Bjornn et al. 1974, Ellis and Gowing 1957, Tebo 1955).

The introduction of sediment into small mountain streams has been known to cause a reduction of the species diversity and density of important trout-food organisms along those areas affected. These reductions, if extensive enough, could cause a displacement of fish inhabiting these areas (Bjornn et al. 1974).

Alteration or elimination of aquatic insect populations, involving both displacement and direct mortality, can be caused by substrate alteration as a result of sedimentation and is well-documented. The extent of change or population alteration is dependent upon many variables, including pre-sedimentation population levels and substrate condition (Cordone and Kelly

1961, Tebo 1955). Studies have shown that rubble is the most productive substrate for bottom organisms desirable as food sources for fish populations. When stream conditions permit the accumulation of sediment and/or silt, the interstices of rubble substrate are filled. Those forms more adapted to the sediment habitat become established, replacing forms that are a source of food for fish. The new forms are generally burrowing in habit, of smaller size, and less accessible as a food supply for fish than those forms typifying the non-sedimented habitats.

Most authors agree that if sedimentation is short-term, localized, and not excessive, aquatic insect populations will return to the pre-sedimentation densities and diversities through recolonization of the affected area by immigration of populations from unaffected upstream areas. It is doubtful, however, that rapid recovery would occur if an entire watershed were subject to the effects of excessive sedimentation (Bjornn et al. 1974, Hynes 1970, Cordone and Kelly 1961, Tebo 1955).

Suspended sediment affects fish distribution directly by reducing visibility, limiting the ability of the fish to locate food sources, clogging of gills by particulate matter, and abrading external structures by the action of suspended mineral solids (Phillips 1970, Saunders 1967, Chapman 1962). The extent and magnitude of these impacts are dependent upon a number of variables, including the species, age, and general health of the fish affected, the quality of water other than sediment, the length of exposure to the sediment, and sediment particle size, shape, hardness, and frequency of introduction.

Most authors conclude that concentrations of suspended solids must be very high to cause direct mortality of fish; in most cases, indirect damage to the fish population through destruction of the food supply, eggs or alevins, or changes in the habitat probably occur long before the adult fish are directly harmed. Mortality of fish eggs caused by sedimentation is well-documented (Elser and Marcoux 1971, Saunder and Smith 1965, Bianchi 1963). Clean permeable gravels provide the nursery areas for fish embryos in the stream environment. Suspended sediment in the water during the incubation period can greatly affect the survival rate of developing embryos by clogging the pore spaces between the gravels. Consequently, the seepage rate and supply of oxygen necessary for successful embryo survival diminishes, resulting in high embryo mortality (Peter 1962). After hatching, fish fry depend on the crevices and interstices in the gravel along the stream bottom for cover and security from predators. An accumulation of sediment can fill these spaces, eliminating escape cover. Phillips (1970) suggests that this increased vulnerability to predators may contribute to increased fry mortality. It has also been documented that spawning fish generally avoid heavily silted waters, and are prevented from successfully spawning if a tributary stream is carrying a heavy suspended sediment load (Smith 1939). The condition of the stream bottom or substrate can be an important limiting factor to trout productivity. Adult fish populations can be seriously affected when sediment accumulation fills important pool areas, reducing available cover and hiding places (Saunders and Smith 1965). Bjornn et al. (1974), working in Idaho, concluded that the summer, and probably the winter, capacity of small mountain streams where most trout reside in pools will be reduced if sufficient sediment is added to a stream to reduce pool area or volume.

Substrate alteration caused by sedimentation will, for the most part, be short-term, occuring during and immediately after the construction activities. However, if the physical characteristics of a stream limit the ability for natural seasonal sediment removal through the normal flushing action of spring flows, substrate alteration has the potential to be of a longer duration.

(iii) Mitigating Measures. The production of sediment in areas adjacent to live stream systems, and its introduction directly into those systems by construction activities, can be greatly reduced by:

(1) Utilizing to the greatest extent possible existing road systems for access.

(2) Limiting new road construction and using helicopters in very sensitive areas

(3) Designing new roads and upgrading existing roads to adequately accommodate the largest and heaviest piece of machinery involved in the construction process

(4) Avoiding steep road grades in favor of lower grades wherever possible

(5) Installation of cross-drainages in roads with unstable soils and steep grades

(6) Providing a natural vegetation buffer or filter strip between roads in valley bottoms and the stream

(7) Locating ridge-top roads so as to avoid headwalls at the source of tributary drainages, since these are often extremely unstable slopes

(8) Restricting wet-weather road construction, particularily on poorly drained erodible soils

(9) Prohibiting disposal of excess fill material within the high-water zone of streams where floods can transport it directly into the stream

(10) Routing of any surface road drainage onto the forest floor, preferably on benches so that sediment can filter out

(11) Choosing the north-facing aspect over a south-facing aspect where there is a choice of aspects for locating a road, since studies have shown the latter to be the most conducive to sediment transport

(12) Avoiding placement of roads in valley bottoms that parallel streams

(13) Placement of roads so as to minimize the number of stream crossings necessary

(14) Avoiding road placement in marshes, bogs, and other areas of permanent or seasonal extreme wetness

(15) Replanting disturbed areas with fast-growing non-competitive native flora

(16) Avoiding location of tower sites on areas with unstable soils, or sidehills and narrow ridge-tops

Where road placement necessitates the direct disturbance of live streams, the production of sediment can be greatly reduced by:

(1) Approaching and crossing at right angles to the stream so as to minimize streambank breakdown and damage

(2) Installing culverts or arch bridges at all road crossings of major streams, or those with importance to the fisheries of the drainage

(3) Use of culverts with sufficient capacity to carry the largest streamflow expected

(4) Avoiding direct use of stream bottom or bank material as a source of construction material

(5) Avoiding work within or adjacent to live streams during periods of high streamflow, intense rainfall, or migratory fish spawning

(6) Removal of excess floatable debris from areas immediately above crossing to prevent culvert obstruction during high waters

The production of sediment in right-of-way areas adjacent to live stream systems by the removal of vegetation associated with the right-of-way clearance can be reduced by:

(1) Positioning right-of-way to avoid the necessity of excessive clearing on steep slopes with unstable soils

(2) Avoiding any excessive clearing in areas adjacent to stream channels

If clearing involves removal of marketable logs, sediment production can be minimized by:

(1) Avoiding use of stream channels for the skidding of logs

(2) Avoiding falling of trees into or across streams

(3) Locating log landings away from stream channels

(4) Yarding logs uphill and away from any stream

The production of sediment from the movement to and from construction sites by large, heavy equipment can be minimized by:

(1) Improving existing access roads to prevent road failure

(2) Restricting use of roads during wet conditions

(3) Restricting movement within the right-of-way to the minimum necessary to complete the job

(4) Avoiding any off-road travel with equipment, especially the fording of small streams

III.C.1.b. Streamflow Impacts and Mitigating Measures

The removal of a large amount of vegetation from a watershed can substantially alter existing streamflow patterns (Rothacher 1972, Hibbert 1967). Alteration of existing streamflow may be greatest where the right-of-way clearance for the proposed transmission line facility necessitates the removal of a large amount of vegetation in small, steep, mountainous watersheds that have a large number of small streams or springs. This alteration of existing streamflow, whether as an increase in peak flows or a decrease in minimum flows, has been known to affect resident fish populations (Carufel et al. 1973, Hynes 1970), particularly if the alteration of flow takes place during critical times, such as spawning, egg hatching, and fry rearing.

The majority of documented studies of streamflow alteration has involved the disturbance of larger areas within watersheds than is anticipated with the proposed transmission line construction. It is anticipated that any alteration of streamflow that may occur as a result of the proposed action will be insignificant.

The risk for creating an alteration of existing streamflow conditions in streams affected by the construction of the proposed transmission line can be minimized by:

(1) Positioning of right-of-way to avoid the necessity of excessive vegetation removal from small headwater drainages of tributary streams

(2) Proper disposal of organic debris away from stream channels and flood plains

(3) Proper installation and maintenance of culverts at all stream crossings by roads

(4) Avoiding excessive vegetation removal on steep slopes adjacent to the stream system

(5) Avoiding excessive compaction of soil along the right-of-way by heavy equipment

(6) Replanting disturbed areas with fast-growing non-competitive native flora

III.C.1.c. Organic Debris Impacts and Mitigating Measures

The risk for introduction of excessive organic debris to streams from activities associated with the construction of the proposed transmission line may occur where right-of-way or road construction necessitates removal by logging of vegetation in heavily forested areas. Organic debris includes the tops, limbs, leaves, bark, and non-merchantable logs or trees directly involved in the clearance. If the debris is allowed to collect in streams, a debris jam or series of jams may present difficult passage, at certain water levels, for migrating salmonids (Narver 1970). This could prevent successful spawning by sport fish utilizing the stream.

Debris jams can affect fish production by means other than physically blocking the stream. Debris, ranging from single logs to large jams, causes instability of the streambed, particularly if the debris shifts position with high flows (Helmers 1966).

Relocation of gravel associated with shifting of debris has been known to result in high salmonid embryo and alevin mortalities (McNeil 1966). Another result of such gravel shifts may be the temporary reduction of bottom fauna (Narver 1970).

Logging debris (particularly leaves, small branches, and bark), when introduced into a stream, can cause a change in the dissolved oxygen content of the water, resulting in a marked decrease in dissolved oxygen both in the intragravel and in the surface waters. This could affect salmonid survival, particularly in small shallow streams during low summer flows when the fish are restricted to pool areas.

The risk for the introduction of organic debris into the stream systems of the study area by activities associated with the construction of the proposed transmission line can be reduced by:

(1) Restricting excessive vegetation clearance in areas adjacent to, or in flood plains of stream systems

(2) Avoiding large, continuous areas of heavy slash, particularily in stream flood plains

(3) Avoiding the falling of trees or brush into or across streams

(4) Hand-clearing of all sections of stream directly affected by the right-of-way clearance or road construction

(5) Proper disposal of road building debris away from stream systems

(6) Encouraging full utilization of woody portion of slash and waste

(7) Retaining adequate buffer strip of vegetation between stream and vegetation disturbance zones

For a listing of related mitigating measures see section III.C.1.a.

III.C.1.d. Thermal Impacts and Mitigating Measures

The risk for thermal impact may occur where the proposed transmission line right-of-way clearance necessitates the excessive removal of vegetation cover from beside streams. Several studies have shown that excessive removal of vegetation cover from beside small streams may increase the maximum water temperature experienced in the streams (Fredriksen 1972, Brown and Krygier 1967). Increased maximum temperatures may cause mortality, particularly of fish in juvenile and embryonic stages; however, the major effect of elevated water temperatures is that it reduces growth, vigor, and resistance to disease (Frediksen 1972).

The risk for thermal pollution within the stream systems of the study area by activities associated with the construction of the proposed transmission line can be minimized by:

(1) Retaining adequate stream buffer strips of native vegetation between roads or right-of-way and the stream system

(2) Minimizing undergrowth disturbance

(3) Avoiding excessive vegetation removal from drainage areas adjacent to the stream

III.C.1.e. Sanitary Waste and Toxic Material Impacts and Mitigating Measures

The risk for introduction of sanitary wastes and toxic material will occur where streams or other bodies of water are near construction storage and service areas. The accidental discharge of fuels, waste oils, and other toxic materials into streams can cause fish kills and damage the water quality of the stream. Improper location of sanitary facilities can cause excessive bacterial concentrations in the water, deteriorating the water quality.

The risk for pollution of the stream systems of the study area by sanitary waste and toxic materials associated with the construction of the proposed transmission line can be reduced by:

(1) Proper location and construction of sanitary facilities away from possible drainage into stream systems

(2) Proper disposal away from any water source of used oil, chemicals, or other toxic substances

(3) Installation of catchment basins at any storage areas to contain accidental spills of fuel, chemicals, and oil

III.C.2. Terrestrial Fauna

Possible impacts upon the terrestrial fauna are of four types: (1) displacement, or population redistribution resulting from disturbance or other environmental change, (2) mortality, or an increase in population death rate, (3) habitat alteration, and (4) stress. Each of these impacts may be either positive or negative, depending upon individual circumstances and the nature of the particular species involved. Also, these impacts may be short-term or long-term; those resulting from the actual act of transmission line construction are short-term, while those resulting from the physical presence of the poles, conductors, cleared corridor, and access roads are long-term, and can affect animal populations as long as the proposed facility exists.

III.C.2.a. Displacement

(i) Short-Term Displacement. The presence of construction crews and their vehicles, the operation of heavy machinery and chain saws, the felling of trees, and the accompanying noise all represent an environmental stimulus to which most wild animals in the study area are not habituated. Nearly all terrestrial vertebrates occupying the right-of-way, access roads, staging sites, pole sites, or the path of heavy machinery, as well as many larger birds and mammals in areas adjacent to the construction site, will respond by moving away from the disturbance. The exact distance moved is dependent upon the nature of the species as well as individual circumstances, and may vary from several feet, in the case of small rodents, to many miles, in the case of larger birds.

The avoidance of active timber removal and road construction by large ungulates, especially elk and moose, is well documented (Allen and Lonner 1974, Ward 1973, Stelfox 1962, Ream et al. 1974, Beall 1974). This displacement may be evident, in the case of elk, up to four miles from the site of disturbance (Lyon 1973).

Breeding birds, notably raptors and colonial water birds, may abandon nests if disturbed repeatedly by nearby construction during the breeding season. Even if nests are not abandoned permanently, flushing of incubating or brooding adults from nests may result in loss of young due to exposure or premature fledging. Sage and sharptail grouse may abandon historical display grounds if disturbed by nearby construction during the breeding season (April and May), resulting in decreased production of young.

Construction-caused displacement is short-term, resulting in the temporary redistribution of animals but not, in most cases, a significant reduction in population size. Most animals displaced by construction can be expected to resume normal activity once construction is completed.

(ii) Long-Term Displacement. Long-term displacement, or the permanent avoidance of a disturbed area, may be equivalent to a reduction in carrying capacity in the sense that previously-used areas are essentially made unavailable to the animals. Long-term displacement may result from: (1) the avoidance of poles and conductors, or (2) the avoidance of roads and vehicular traffic. Both are discussed below.

There is no evidence that populations of big game animals within the study area will be permanently displaced as a result of the physical presence of transmission line poles and wires, induced electromagnetic fields, or noise created by corona discharge. Big game animals apparently do not avoid transmission lines in operation, even during periods when corona discharge produces an audible hum (Figure 6-12). Big game animals apparently become habituated to the constant noise produced by the lines, much as they become habituated to natural sounds such as those produced by streams or wind. Goodwin (1975), in a study of big game movements near the Dworshak-Hot Springs 500-kV line in northern Idaho and western Montana, found that big game use of the right-of-way was not significantly different from that of natural clearings having similar amounts of available food. As many as 59 bighorn sheep were observed in spring on a multiple corridor near Thompson Falls, Montana. This corridor contained one 500-kV line, one 230-kV line, and three 115-kV lines.

Waterfowl, in contrast to big game mammals, are known to avoid transmission lines while in flight by distances of up to one-half mile in certain areas (Hunt 1972, Bellrose 1968, Kowalski 1968, Bonde 1970, Drennen 1968, Gunter 1956, Byczynski 1968). These birds are apparently reacting to light reflected by the lines, the humming of the lines, and the visual configuration of the lines, especially when the lines are swaying in the wind. There is no documentation of waterfowl avoidance of transmission lines in Montana, however, and many wetland areas in eastern Montana which are crossed by power lines are heavily used by waterfowl. Several species of birds (notably osprey, ravens, red-tailed hawks, and golden eagles) are known to nest on the poles or towers of operating transmission lines as high as 500-kV in capacity (Figure 6-13).

Avoidance of roads and vehicular traffic include impacts associated with post-construction human activity occurring in the vicinity of transmission lines as a direct result of the existence of access roads and the right-of-way. The magnitude of these impacts within the study area may vary tremendously from area to area, and depends upon a complex interaction of many site-specific variables, including the location of existing roads, distances to population and developed recreation centers, and the type and location of access roads. In most cases, animals do not avoid roads per se; they are rather reacting to

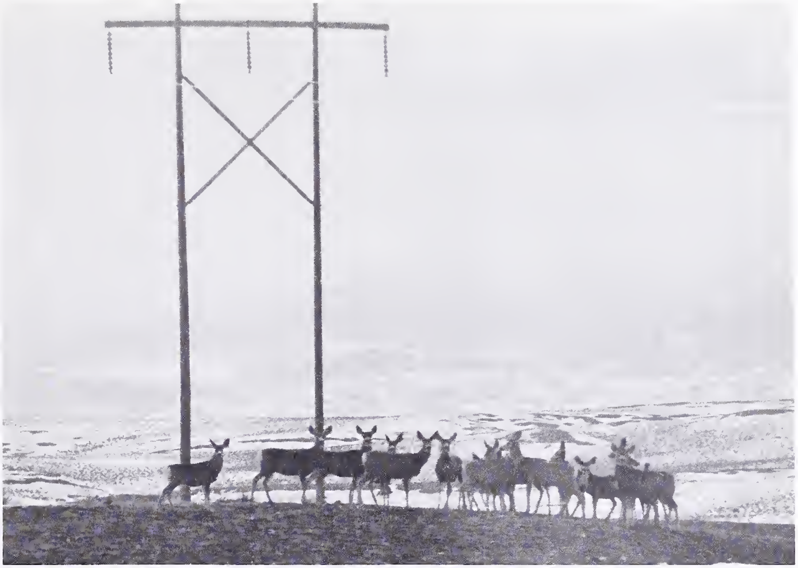


Figure 6-12. Mule deer on a winter range near Clyde Park do not avoid 161-kV transmission lines in operation in spite of a noticeable hum. Apparently, the deer become habituated to the noise much as they become habituated to natural sounds such as those produced by streams or wind.

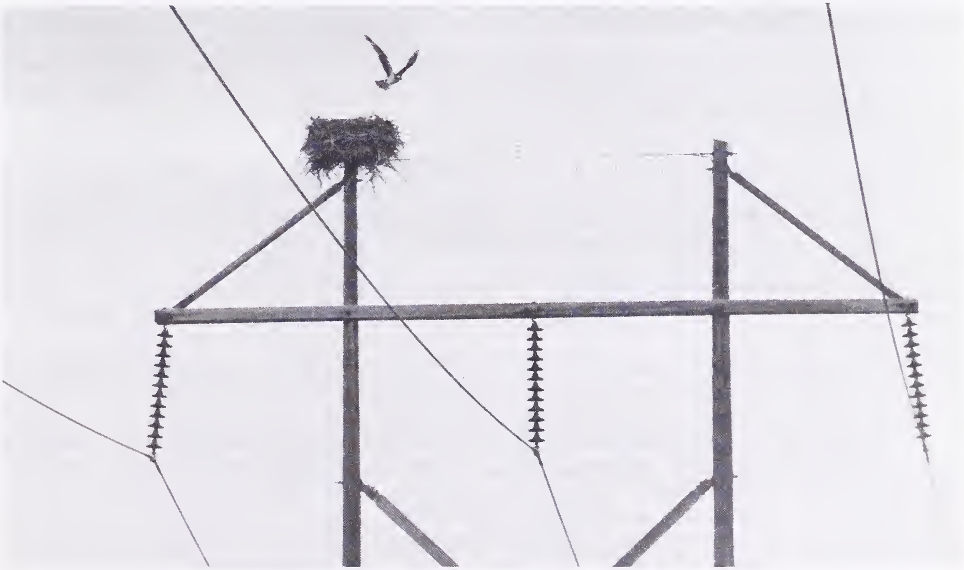


Figure 6-13. Birds of prey occasionally use transmission line support structures as nesting sites. This photograph shows an osprey nest built on a 230-kV double-pole tower structure near Ovando. The effect of induced electromagnetic current surrounding the conductors on the developing eggs and young birds is unknown; this nest has successfully produced young for several years.

the movement of vehicles and the presence and activity of human beings associated with roads. The greatest potential for adverse impact to large mammal populations lies in the construction of new access roads along the proposed transmission line, and the possibility of the transmission corridor opening previously roadless areas to future transportation corridors.

The reactions of animals to roads and associated human activities are dependent upon a number of complexly interrelated variables. Some of those listed by Rost et al. (1974) include: (1) species of animal, (2) age and type of road, (3) density of traffic, (4) construction associated with the road, (5) distance from the road, (6) vegetation type, (7) season, (8) whether the big game population is hunted, and (9) whether the road is located in an abundant, or in a scarce and limiting, habitat type. It is evident that the nature and magnitude of impacts related to transmission line access roads may vary tremendously, depending upon the exact nature and location of the access road.

Most mammals and birds can adapt to, or become conditioned to, many kinds of unfamiliar environmental stimuli which are initially disturbing and which initially cause a flight or avoidance response, provided the stimuli are constant or repeated regularly. For example, an attempt was made in northern Idaho to drive nuisance elk from cultivated fields with firecrackers and exploding rockets, but the elk became conditioned to these repeated disturbances after four to five days and no longer responded to them by fleeing (Blackburn 1975). Similarly, big game animals can become conditioned to constant vehicular traffic, even if traffic is heavy and noise levels are high, and are often seen feeding near interstate or other major highways. However, disruption of this rhythmical traffic pattern represents a new, unfamiliar stimulus; the animals will usually cease feeding and move if a vehicle suddenly stops nearby and its occupants appear. Where traffic is infrequent or highly irregular, as on many dirt or primitive mountain roads, there is little opportunity for animals to become conditioned to traffic, and their avoidance of vehicles is greatest.

Elk appear to be among the most vulnerable species to displacement by vehicular traffic. Many studies have documented the avoidance of roads by elk (Sundstrom and Norberg 1972, Allen 1971, Lyon 1974, Lyon and Janson 1974, Rost et al. 1974, Allen and Lonner 1974), but others (Ward 1973) suggest that traffic has little effect on elk activity beyond 300 yards. The sensitivity of elk to disturbance is largely dependent upon season and condition of the animal; also, many logging roads which are avoided during daylight hours, when traffic is present, are freely crossed at night. Other big game mammals, including moose, mountain goats, and deer, are also known to avoid roads and associated human activity.

Dispersed recreation and off-road vehicular travel, especially snowmobile use of the cleared right-of-way, can also result in displacement of large ungulates (Ward 1973, Ward et al. n.d., Savage 1972, Wanek 1971, Baldwin and Stoddard 1973, Schladweiler 1974, Goodwin 1975). Deer apparently can become readily habituated to light, constant snowmobile activity; however, deer react violently to snowmobile invasions into areas where snowmobiles seldom travel. Elk appear less tolerant than deer to snowmobiles, and will move relatively great distances in an attempt to maintain at least one-half mile between the snowmobile and themselves.

Long-term displacement resulting from access roads and the cleared corridor can effectively reduce the amount of available habitat over an area much greater than that of the road itself, an area which, in the case of elk, may include a quarter of a mile or more on either side of the road. This may be equivalent to a reduction in the carrying capacity of the environment with respect to the species affected.

III.C.2.b. Mortality

The population consequences of mortality are likely to be insignificant, unless mortality is heavy and continued, or the species suffering increased mortality is exceptionally rare and has a very low reproductive potential. Increases in mortality rates are normally compensated for by an increase in birth rates, and populations suffering a depression in numbers following an episode of mortality are likely to eventually return to baseline levels (in the case of non-cyclic populations). The impact of mortality is expected to be significant only in the cases of: (1) large colonies of colonial species, such as great blue herons or prairie dogs, (2) species with an exceptionally low reproductive potential, such as the trumpeter swan, and (3) species which are very rare or in danger of extinction, such as the peregrine falcon or grizzly bear.

(i) Short-Term Increases in Mortality Rates. The slight increases in mortality which may result from construction or shooting by construction workers are expected to be insignificant, with the few exceptions noted above.

(ii) Long-Term Increases in Mortality Rates. The presence of poles, conductors, and access roads may affect mortality rates of certain animals through: (1) wire strikes, (2) shooting, (3) electrocutions, and (4) changes in the distribution of hunting pressure, each of which is discussed below.

Collisions with utility wires, or wire strikes, have been known to result in the mortality of waterfowl (Cornwell and Hochbaum 1971, Peterson and Glass 1946, Burgess 1973, Boyd 1961, Harrison 1963, Krapu 1975, Beer and Ogilvie 1972, Walkinshaw 1946, Stout 1967, Willard and Willard 1972) and a wide variety of other birds, including ring-necked pheasant (Krapu 1975), sage grouse (Myers 1975, Borell 1939), hummingbirds (Hendrickson 1949), and sandhill cranes (Walkinshaw 1956). Raptors, due to their superior eyesight, are seldom the victims of wire strikes.

Waterfowl generally migrate at sufficient altitudes that collisions with power lines are unlikely, except near feeding, nesting, or resting areas, or over mountain passes or high ridges, where birds fly near the ground. As mentioned earlier, most waterfowl seem to avoid transmission lines where possible. Wire strikes by waterfowl are most frequent during spring and fall migrations, when the birds are passing through relatively unfamiliar terrain and during windstorms, snowstorms, periods of heavy fog, or other meteorological phenomena which reduce visibility (Banko 1960, Quortup and Schillinger 1941, Schorger 1952, Williams 1950). Mortality caused by wire strikes is likely to represent a relatively small percentage of the total mortality of waterfowl.

The tendency of large raptors to perch on utility poles in open areas makes them vulnerable to illegal shooting, especially in areas where the transmission line closely parallels paved or gravel roads or where the public has access to maintenance roads (Boeker n.d., Hannum et al. 1974, Ellis et al. 1969).

Electrocution of birds perching on power lines, especially raptors, has been well documented (Boeker n.d., Hannum et al. 1974, Richardson n.d., USDA 1972). However, nearly all electrocutions are associated with power distribution lines; the distances between conductors, and between the conductors and ground wires are sufficiently great on double-pole 161-kV lines that electrocutions are highly unlikely (Crawford and Dunkeson 1973, Hannum et al. 1974).

Depending again upon the exact nature and location of the corridor, access roads have the potential to alter the present distribution of hunters and fishermen, and to change the rate of harvest mortality of many game species. In areas already heavily roaded, increased access by hunters could further reduce the availability of security areas to big game, and result in harvest quotas being reached faster. This may result in more restrictive hunting regulations, and reduce the quality and quantity of hunting opportunities available in a given area. However, in certain areas where natural predators are lacking, increased access could aid in the hunting of under-harvested herds and result in better herd survival during severe winters (Goodwin 1975, Allen 1971, Bumstead 1971, Lonner 1974).

III.C.2.c. Habitat Alteration

A short-term habitat alteration may be created by the crushing or removal of vegetation during construction, affecting the availability of cover and forage for many species. However, revegetation or succession will eventually replace the original vegetation. Impacts resulting from the presence of permanent access roads and the maintenance of a treeless corridor through timbered areas are long-term, and can affect animal populations as long as the facility exists. If the alteration of habitat is extensive, it may result in changes in carrying capacity for one or more species.

Destruction of a relatively small amount of habitat may not result in an immediate departure of population levels from carrying capacity; however, it should be realized that the piecemeal erosion of habitat places irreversible constraints on the future abundance and distribution of animal species, and may be significant as habitat destruction due to other causes continues.

Long-term habitat alteration is expected to result from: (1) permanent access roads, (2) timber and brush removal along the right-of-way, and (3) the routing of the line through roadless or wilderness-like areas.

Where permanent access roads are maintained along the right-of-way, a small amount of habitat equivalent to the area of the road will be permanently lost. This is expected to be insignificant, unless a high percentage of a habitat which is limiting to a species is destroyed, as in the case of willow-bottom moose habitat. Habitat changes resulting from timber removal along the right-of-way can result in increased snow depths which can bury forage and impede travel of larger mammals; increased wind velocities, which may result in chilling animals during storms, and cause a decrease in animal use of the area; and increased insolation, which may increase summer ground temperature (Pengelly 1972, Hilbebrand 1971).

Where timber removal along the right-of-way opens the forest canopy, extensive changes in understory vegetation may occur, depending upon the moistness and existing shrub cover of the forest type. Shrub regeneration is poor on drier sites, while moist sites are likely to produce abundant browse, grasses, and forbs, which provide food for a variety of herbivores as well as cover for many small mammals and birds (Basile and Jensen 1971, Pengelly 1963, Edgerton 1972, Patton n.d., Resler 1972, Warner 1970, Bramble and Byrnes 1972). Several studies have shown that the removal of timber in narrow strips, such as a power line right-of-way, can be beneficial to large herbivores because abundant forage is available a short distance from cover (Resler 1972, Goodwin 1975, Reynolds 1960, Wallmo 1969).

It is well known that habitat diversity is reflected in species diversity; the greater the diversity of habitat in a given area, the more species generally occupy that area. Also, the greatest species diversities are often found along ecotones between broadly different habitats, a phenomenon known as the "edge effect." The vegetation mosaics and edges created by right-of-way clearing through uniform timber stands can be expected to substantially increase animal species diversity along the right-of-way.

While certain species will benefit from vegetation changes resulting from clearing of the right-of-way, as discussed earlier, others will be adversely affected; however, in most cases, more species will colonize the right-of-way than will be eliminated, and the net result will be an increase in diversity. Species which are adapted to climax forest situations decrease or are eliminated as a result of forest clearing, while species perferring open-canopy situations, ecotones, and seral vegetation (especially seed-eating species), will increase or colonize the area (Gashweiler 1970, Lay 1938, Resler 1972, Bendell and Elliott n.d., Madson n.d., Tevis 1946, Heath 1973, Hagar n.d., Gysel n.d.).

Many of the environmental factors which characterize roadless or wilderness-like areas also characterize the preferred habitat of "wilderness species," which include the grizzly bear, mountain lion, and marten. Some identifying characteristics include the absence of roads, the absence of operating vehicles and other machinery, and absence of permanent human dwellings or developments, and a relatively low density of humans. Whatever the reasons for the preference of these species for wilderness-like areas, it is highly likely that elimination of some or all of the wilderness-like characteristics of these areas will make them less suitable for wilderness-loving species, and may result in the eventual reduction or elimination of populations of these species from the area.

The amount of wilderness-like land presently remaining in Montana represents a maximum; there is little man can do to increase it, but there are many things he can and does to reduce it. One of the most effective ways of reducing the amount of wilderness-like land is to bisect or fragment existing roadless areas with new roads. This will destroy certain of the wilderness-like characteristics, especially the low density of humans, over an area much greater than that of the road itself, including a fringe of land of variable extent on either side of the road. Thus, if a wilderness-like area is bisected by a road, the actual amount of wilderness habitat which remains will be considerably less than the combined areas of the two halves.

III.C.2.d. Stress

The impacts of increased stress levels due to construction, harassment, or habitat alteration may not result in immediately observable population changes. For example, although increased stress may not result directly in mortality, it may predispose individuals to mortality from other causes, such as predation, disease, or starvation. Stress may also indirectly affect population size by lowering reproductive success or by inducing abortions. Population condition and biomass may be affected by the imposition of added stress, even if population size is not changed. Generally, even slight increases in stress and the expenditure of stored energy resulting from transmission line-related impacts are important during winter, when most vertebrates are already subjected to severe stress. Once the consequences of stress become observable, the impact to the system has often progressed to an extent not readily correctable.

Gaseous oxidants and electromagnetic fields, although produced by overhead 161-kV transmission lines, are produced in such low levels that they are not expected to significantly increase stess levels of animals living or passing beneath the lines (Jaffe 1967, Frydman et al. 1972, Scherer et al. 1972, Fern and Brabets 1973, Kouwenhoven et al. 1967, Young and Young 1974, Riesen et al. 1974, Bingham and O'Neil 1974, and others).

III.C.2.e. Indirect Impacts

In addition to the direct impacts discussed above. a number of indirect impacts may result if the proposed facilities are constructed. These are not usually considered part of the impacts of high-voltage energy transmission, but may have real population consequences to the fauna both within Montana and in other parts of the world. These include impacts associated with the acquisition of raw materials and the manufacture and transportation of materials to be used during construction of the proposed facility (including poles, wire, and fuel), as well as impacts associated with increased future residential, industrial, or recreational development of the study area resulting from increased access and power availability.

III.C.2.f. Mitigating Measures

Many of the possible adverse impacts to the terrestrial fauna of the study area can be prevented or greatly reduced, even where the center-line crosses a particularly sensitive area, by making a few changes in the methods or timing of construction. Several steps which may be taken to dampen or eliminate impacts are listed below:

(1) Much displacement of large ungulates, due either to construction or access, can be minimized by routing the center-line through areas which the animals already avoid, e.g., large clearcuts or industrial areas, or where the animals are already somewhat habituated to human activity, e.g., along existing roads or highways.

(2) By following existing utility or transportation corridors wherever possible, the necessity of access road construction and the probability of impacts associated with access roads (displacement, reduction of security areas, alteration of wilderness habitat, etc.) can be eliminated.

(3) Where the corridor crosses roadless areas, the impacts associated with access roads can be reduced by employing roadless construction methods, such as helicopter construction, wherever possible. Where access roads must be constructed through previously unroaded areas, impacts can be reduced by restricting or prohibiting traffic on the new roads once construction is complete.

(4) By siting the center-line in grassland areas rather than forested areas, and by using existing forest clearings or treeless areas wherever possible, extensive clearing of the right-of-way through forested areas and associated impacts (as well as the amount of time construction crews must spend in the area) can be minimized.

(5) Much unnecessary disturbance to vegetative cover and animals outside the right-of-way can be reduced if measures are taken to prohibit off-road travel by construction crews and their vehicles.

(6) Where a corridor must be cleared through densely timbered areas, browse and shrub production along the cleared corridor can be maximized by routing the line through those moister forest sites containing abundant understory shrubs. Also, possible interference with movements of big game mammals can be reduced by making frequent bends in the right-of-way rather than clearing a straight "tunnel corridor" allowing a long, unobstructed view.

(7) Waterfowl and upland game bird losses due to wire strikes can be minimized if care is taken to avoid the immediate vicinity of waterfowl concentration areas, and to avoid separating traditional sage grouse feeding and strutting areas.

(8) Where the corridor crosses elk summer range, care should be taken to insure that security areas, inaccessible to motor vehicles and separated by at least one topographic feature

from the construction site, are preserved nearby. Disturbance to elk can be further reduced by avoiding ridge-top construction or access roads.

(9) Much of the adverse impact of transmission line construction upon mammals and birds can be avoided by restricting construction through seasonal use areas or in the vicinity of breeding sites to seasons when biological activity is least (see Figure 6-8).

(10) Where construction must take place in a seasonal use area at a time when it is occupied, the magnitude of displacement-related impacts can be lessened if construction activities are planned so that the necessary construction can be accomplished as quickly as possible.

6.3.2.6. Meteorology

I. Introduction

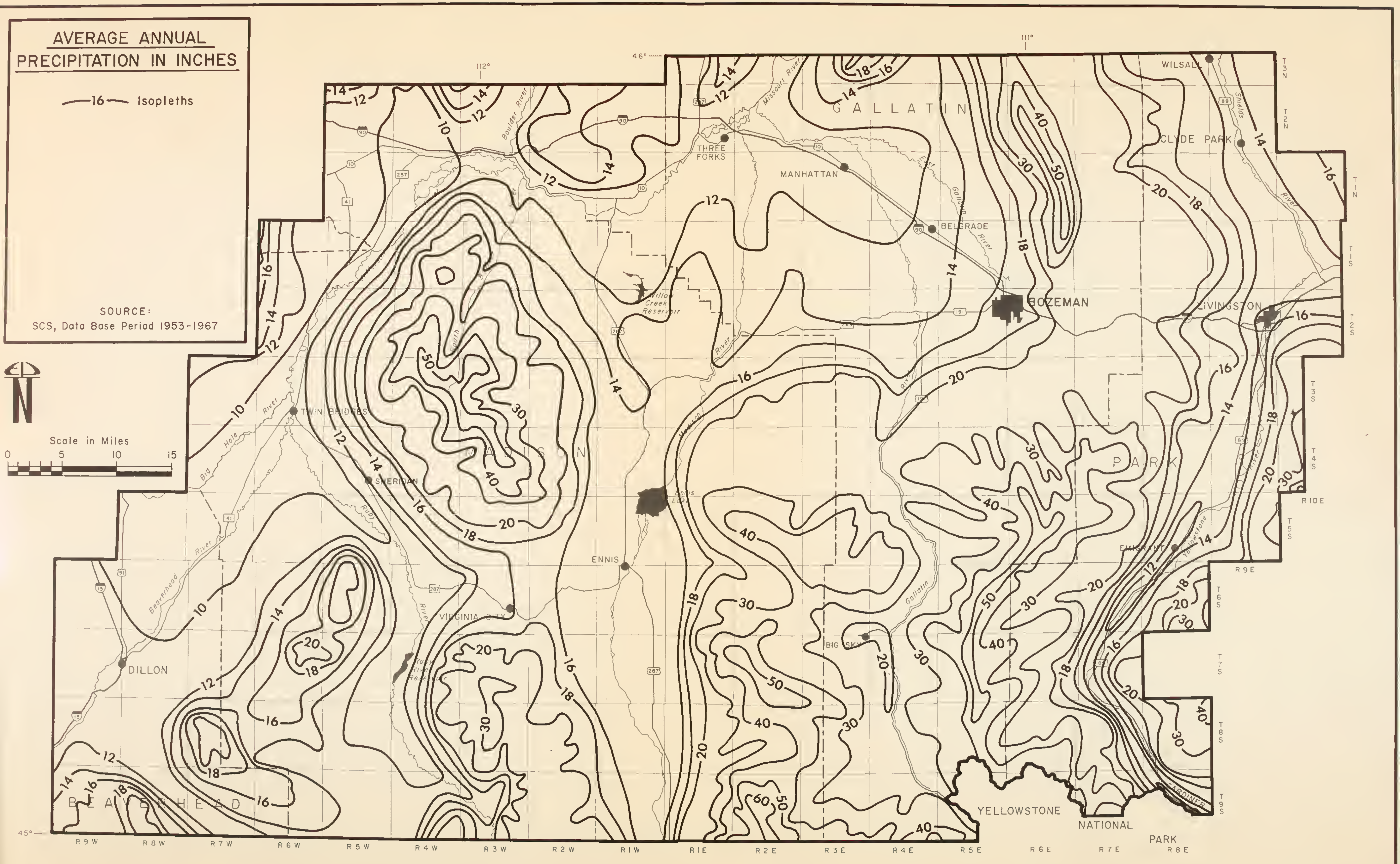
Of the available climatic data for the study area, only average annual precipitation data have sufficient aerial coverage for transmission line corridor selection. Therefore, this section is brief, as only precipitation data is used in the corridor selection. Other climatic influences are included implicitly in the evaluations on vegetation (6.3.2.4.), soil (6.3.2.3.), and wildlife habitat (6.3.2.5.).

Some meteorological information has been inventoried in this section, including discussions on climatic differences in the study area, precipitation, temperature, freeze-free seasons, and severe weather. No general impacts section is provided for this section, as it is not necessary. Instead, the precipitation map presented in this section is combined with other physiographic information in section 6.3.2.2. to provide an indication of landslide hazard.

II. Inventory

II.A. Climatic Differences in the Study Area

The climate throughout the study area varies in response to the variation in topography. Southwestern Montana, which includes this study area, contains several mountain ranges which are interrupted by river valleys. Elevations at the valley floors range from 4000 to 5000 feet MSL, while the mountains rise to heights exceeding 10,000 feet. (For a more detailed description of the study area physiography, see section 6.3.2.2.) Climatic differences of considerable magnitude are possible over short distances because of the combined effects of the elevation differences and differences in slope exposure. As elevation increases from the valley floor to the mountain crests, wind speeds and total precipitation will generally increase, while mean temperature and temperature range will generally decrease.



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Relative humidity will tend to increase with elevation in summer, and decrease with elevation in winter (Landsberg 1969, pp. 309-317). Windward, western slopes will receive more precipitation than leeward, eastern slopes, and south-facing slopes will receive more sunshine than slopes with a northern exposure.

II.B. Precipitation

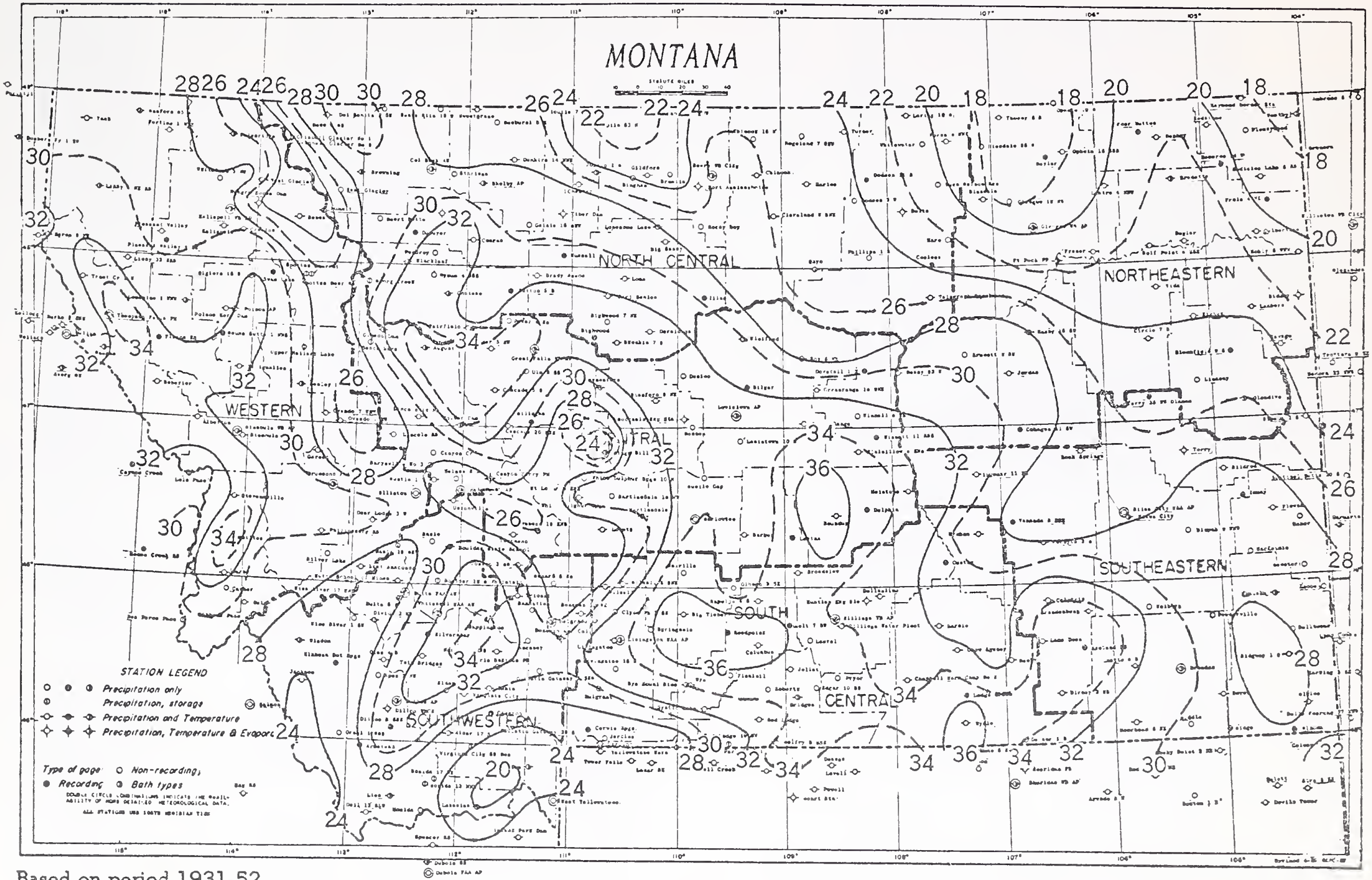
The average annual precipitation in the study area is shown on the Average Annual Precipitation map for the 1957-1967 base period. Annual totals for the valley floors are in the 10-16 inch range, while the high mountain regions annually receive up to 60 inches. The small total precipitation amounts for the valleys would tend to indicate a climate unsuitable for agriculture. However, such is not the case because of the temporal distribution of the precipitation, and because of the moisture which falls in the surrounding mountains. Throughout the study area, valley stations record almost three-fourths of their annual precipitation during the April to September growing season. Also, a pronounced precipitation maximum occurs early in the growing season during the months of May and June, when 30 to 40% of the annual precipitation falls (U.S. Dept. of Commerce 1965). Precipitation in winter generally falls as snow (U.S. Dept. of Commerce 1970, U.S. Dept. of Commerce, no date). The direct valley precipitation is supplemented by run-off from the May-June snowmelt and the increased amounts of precipitation during the remainder of the year in the surrounding mountains (U.S. Dept. of Commerce, no date a).

II.C. Temperature

II.C.1. Winter

Winters in the study area are cold, but severe cold temperatures are infrequent. Mean monthly temperatures in December, January, and February are generally in the 10's (°F) at the reporting valley weather stations (U.S. Dept. of Commerce 1965). Figures 6-14 and 6-15 are U.S. Weather Service maps of mean, maximum and minimum temperatures in January. The severe cold waves and associated subzero temperatures, which may cover parts of eastern Montana six to twelve times during an average year, penetrate southwestern Montana as far as Dillon two to three times each year (U.S. Dept. of Commerce 1971, U.S. Dept. of Commerce, no date a). When cold outbreaks reach the study area, they usually last only two to three days, and are often ended by the onset of warm southwest winds (U.S. Dept. of Commerce, no date a and b). In the Livingston area, the warm downslope winds, popularly known as "chinook" winds, sometimes reach peak qusts of 100 miles per hour (about once in 10 years), and can produce temperature rises of 50° to 60° in a 24-hour period (U.S. Dept. of Commerce, no date b). The coldest reported temperature in the study area is -45°, which occurred in February 1936 at Livingston (U.S. Dept. of Commerce 1965).

Mean Maximum Temperature (°F.); January



Based on period 1931-52

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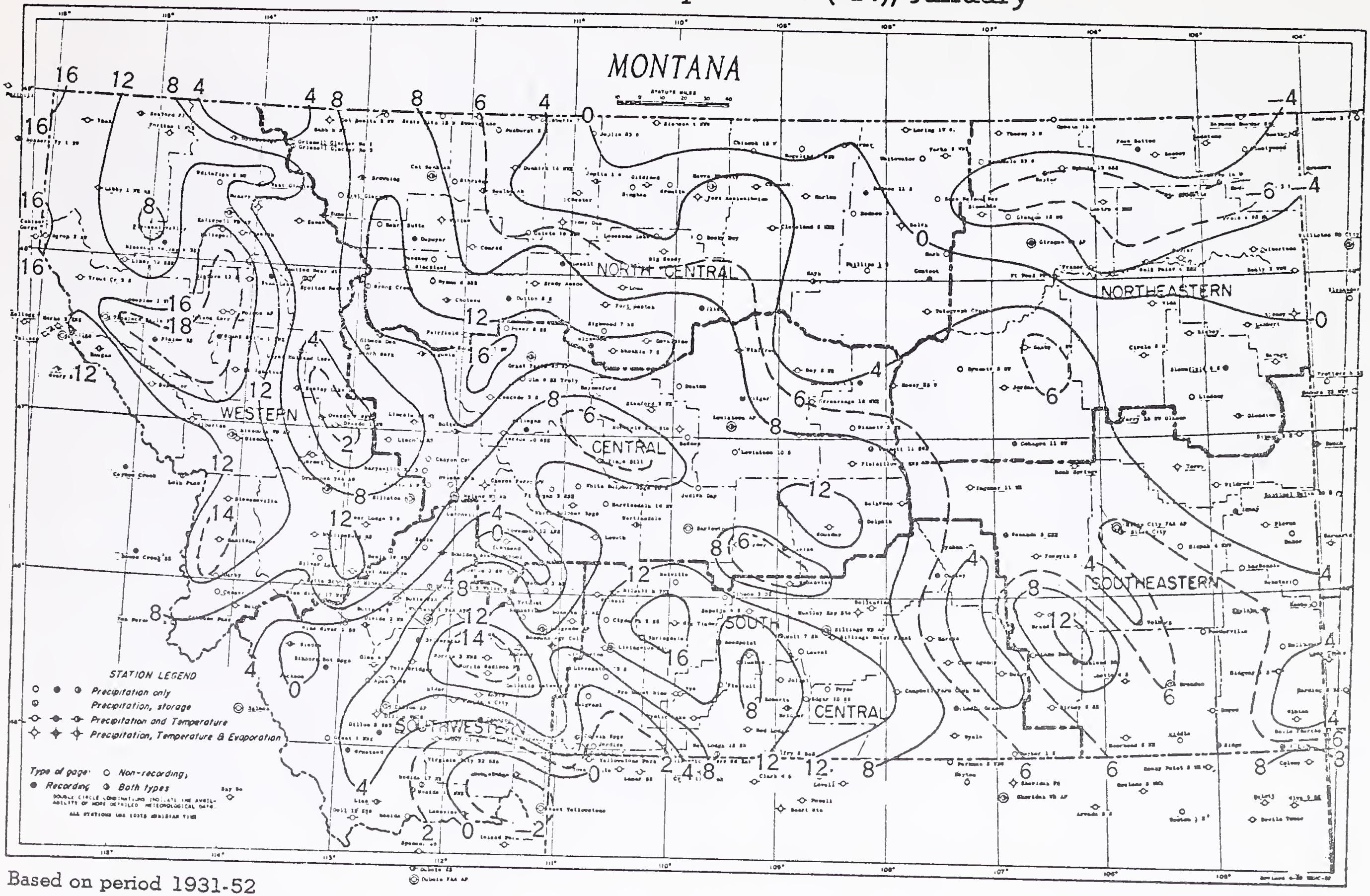
Isolines are drawn through points of approximately equal value. Caution should be used in interpolating on these maps, particularly in mountainous areas.

FIGURE 6-14

Mean Minimum Temperature (°F.); January



Based on period 1931-52

Isolines are drawn through points of approximately equal value. Caution should be used in interpolating on these maps, particularly in mountainous areas.

FIGURE 6-15

II.C.2. Summer

Summers in the study area consist of warm days and cool nights. At the reporting valley stations, the mean daily maximum temperatures in July, the warmest month, range in the low to upper 80's, while the mean daily minimums for the same month drop to the upper 40's and low 50's (U.S. Dept. of Commerce 1965). Weather Service maps of mean maximum and mean minimum temperature in July are shown in Figures 6-16 and 6-17. The highest verified temperature on record in the study area is 106^0, which occurred on July 31, 1901, at Livingston (U.S. Dept. of Commerce 1965, U.S. Dept. of Commerce no date b). Relative humidity in the summer is rarely high enough to cause comfort problems (U.S. Dept. of Commerce 1970, U.S. Dept. of Commerce no date a and b).

II.D. Freeze-Free Seasons

Variation in the average length of the freeze-free season in the study area is shown on the map entitled "Average Length of Freeze-Free Season," taken from Caprio (1965). The valley floors may enjoy average freeze-free seasons in excess of 115 days, while the mountain peak regions have similar seasons averaging less than 30 days. Table 6-10 lists the probability of the occurrence of a freeze-free season shorter or longer than the average values given on the map.

II.E. Severe Weather

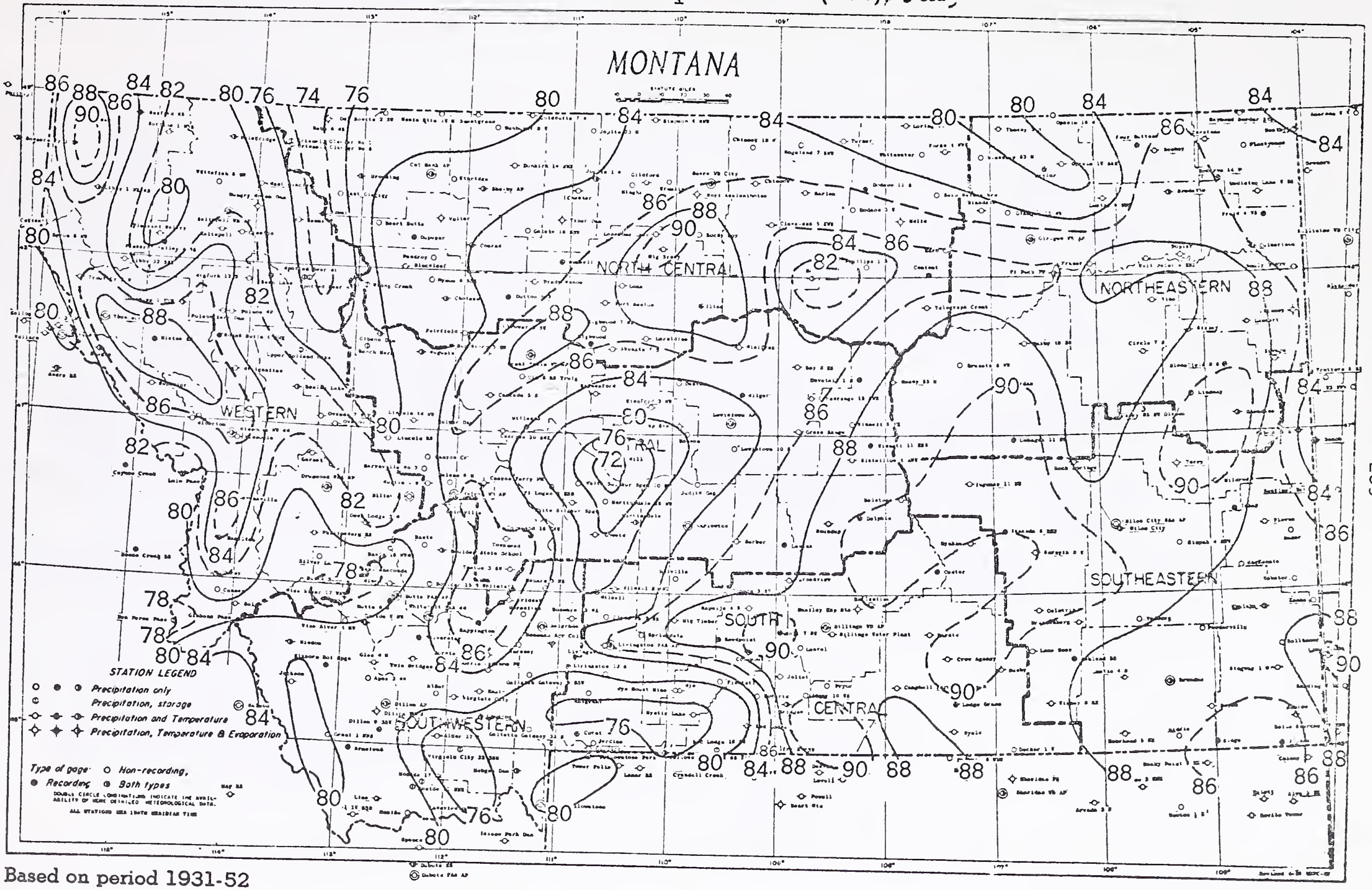
The available information indicates that severe weather occurs only rarely in the study area (U.S. Dept. of Commerce 1970, U.S. Dept. of Commerce no date a and b). High winds occur in the Livingston area, but as mentioned above, the 100-mile-per-hour peak gust speeds occur only about once in 10 years. Thunderstorms occur occasionally during summer months, and a specific estimate of 30 thunderstorm days per year has been given for Dillon (U.S. Dept. of Commerce 1970, U.S. Dept. of Commerce no date a and b). Maps drawn by Stout and Changnon, Jr. (1968), indicate that hail can be expected in the study area on 50 to 100 days in an average 20-year period, with the maximum occurrence frequency in the Dillon area. Damaging tornadoes would not be expected in mountainous southwestern Montana.

6.3.3. Cultural Environment

6.3.3.1. Introduction

Analytically, a transmission line has five aspects; an electrical, physical, aesthetic, fiscal, and symbolic presence. For any given project these dimensions will vary in intensity, importance, or concern. The site, scale, design, need, and location of a project are input variables relevant to a line impact in the physical, electrical, or symbolic dimension, etc. However, to judge the overall impact of a transmission line, it is necessary to examine the facility using the five analytical dimensions within parameters peculiar to a specific application. In the sections that follow, information will be presented germane to a discussion of each analytical dimension. The

Mean Maximum Temperature (°F.), July



Based on period 1931-52

Isolines are drawn through points of approximately equal value. Caution should be used in interpolating on these maps, particularly in mountainous areas.

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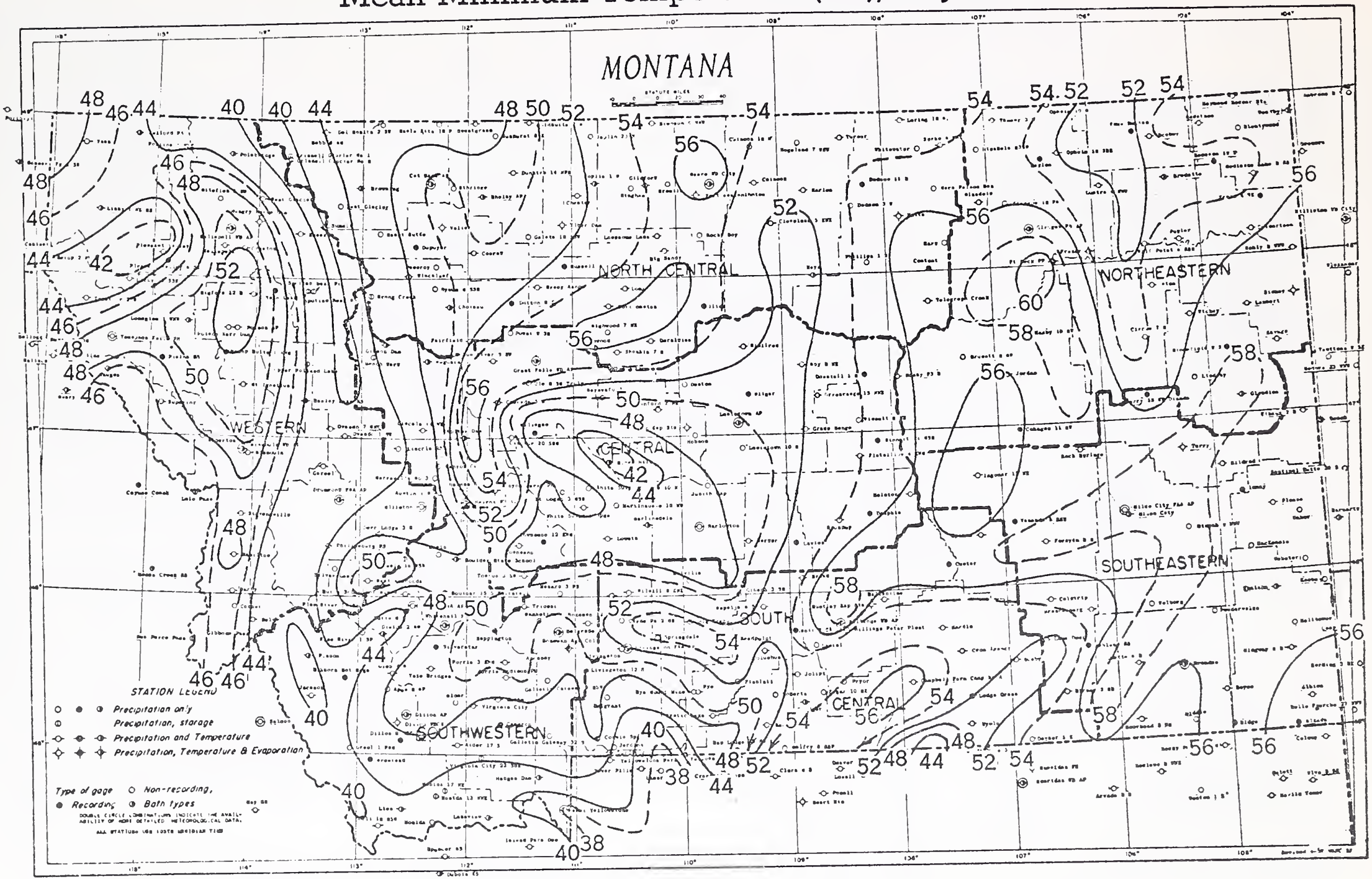
FIGURE 6-16

Mean Minimum Temperature (°F.), July



Based on period 1931-52

Isolines are drawn through points of approximately equal value. Caution should be used in interpolating on these maps, particularly in mountainous areas.

FIGURE 6-17

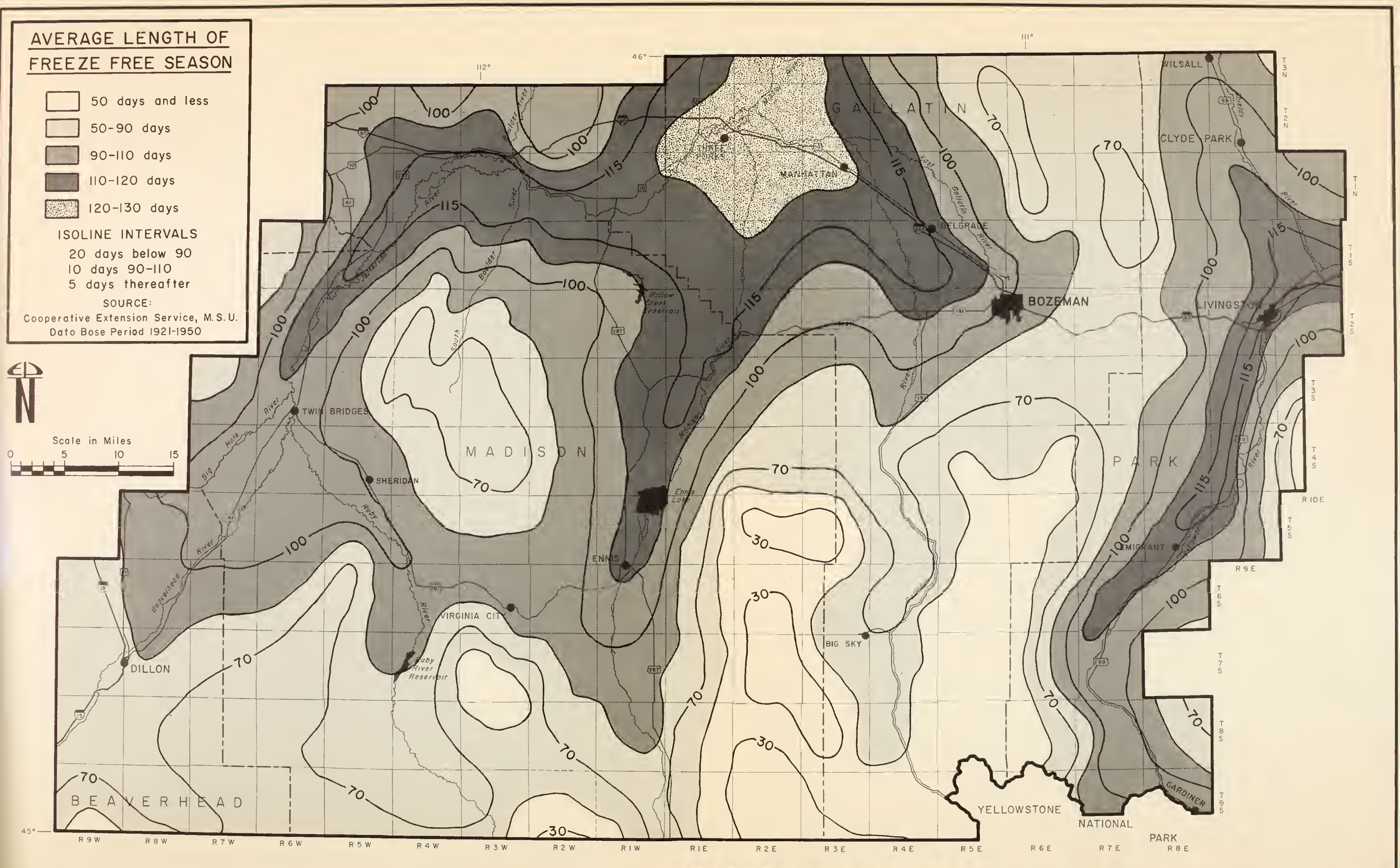


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TABLE 6-10

PROBABILITY OF A LONGER OR SHORTER FREEZE-FREE SEASON THAN AVERAGE

Probability That The Freeze-Free Season Will Be At Least:	
30 days less than average length	5% or 1 year in 20
23 days less than average length	10% or 1 year in 10
13 days less than average length	25% or 1 year in 4
Average Length	50% or in half the years
13 days longer than average length	25% or 1 year in 4
23 days longer than average length	10% or 1 year in 10
30 days longer than average length	5% or 1 year in 20

SOURCE: J.M. Caprio, "Average Length of Freeze Free Season," Folder No. 83. Cooperative Extension Service, Montana State University. Bozeman, Montana; March 1965.

physical presence of the line is treated in an examination of land use (see section 6.3.3.2.). A discussion of project economics considers the line's fiscal presence (see section 6.3.3.3.). Symbolic content is reviewed under the heading of social impact analysis (see section 6.3.3.4.). The aesthetic and electrical aspects of the line are studied from a multidisciplinary perspective combining sociology with landscape architecture or economics (see section 6.3.3.5.).

For these evaluations, the temporal aspect of impact analysis is largely ignored, as a discussion of construction versus operational phase impacts is more applicable to other disciplines. From the "people" impact point-of-view, construction phase impacts are generally short-term, difficult to measure, and off-site. Construction impacts offer little input to solving the problems of choice between alternative utility corridors. Therefore, evaluation of the Clyde Park-Dillon application is made assuming an installed facility.

6.3.3.2. Land Use

I. Introduction

The physical presence of a transmission facility registers an impact on land use. The presence of tower structures, electrical conductors, and associated substation facilities limits and/or precludes the use of land in certain ways. The incompatibility of sprinkler irrigation and transmission line tower structures is a common illustration of competing land use requirements. A discussion of land use inventory is initiated in this section with a description of the existing land use of the study area. Maps have been prepared to illustrate use and ownership patterns. Each map and its constituent elements is described in the text. Information for this inventory was drawn from tax rolls compiled by the Assessor of Park, Gallatin, Jefferson, Broadwater, and Madison Counties. Land use maps prepared by the Montana Water Resources Division contained the most recent information available for Beaverhead County. Aerial photographs and on-site field evaluations were used to verify the accuracy of all information sources. A general discussion of land use impacts and corridor constraints follows the inventory write-up. Site-specific land use evaluations and impacts are contained in the following chapter.

II. Inventory

II.A. Site Patterns

Land use site patterns are limited by physical features of the environment, such as topography, water availability, physiography, vegetative cover, climate, and soil capability, and by cultural factors, such as the location of population centers, transportation routes, and power sources (see Figure 6-18). The distribution of site patterns within the Clyde Park-Dillon study area can be seen on the maps which have been prepared for the following land use categories:

Figure 6-18. Diverse topography and varied landscapes are prevalent throughout the study area.

1. Ownership. This map depicts federally-owned, state-owned, and privately-owned lands.
2. Existing Land Use - Site Patterns
    - (a) Agricultural land use, including irrigated land, dry cropland, rangeland, and wild hayland
    - (b) Urban and residential land use, including urban areas, small communities, and scattered built-up areas
3. Recreation. This map delineates state parks, campgrounds, other terrestrial-related activities (both nature and culture-oriented), and other water-related activities.
4. Historic and Archaelogic Sites. This map shows nationally registered historical sites, state historical sites, archaelogic sites, and ghost towns.

5. Specially Managed Areas. This category includes primitive areas, new study areas, non-selected roadless areas, citizen-proposed study areas designated by Senate Bills 355 and 393, game management areas, and streams designated as special areas.

In addition to the mapped categories listed above, the following unmapped categories are discussed in the text:

1. Woodlands
2. Water Areas

The amount of non-federal land within several of the land use categories outlined above is summarized in Technical Appendix J for the counties in the study area. Information was adapted from the Montana Soil and Water Conservation Needs Inventory (SCS 1970).

II.B. Land Ownership

II.B.1. Differences Between Land Use and Land Ownership

A discussion of land ownership should begin by making a distinction between the terms "land ownership" and "land use." Sometimes it is difficult to differentiate between the two, as they are closely related. However, some basic differences are apparent.

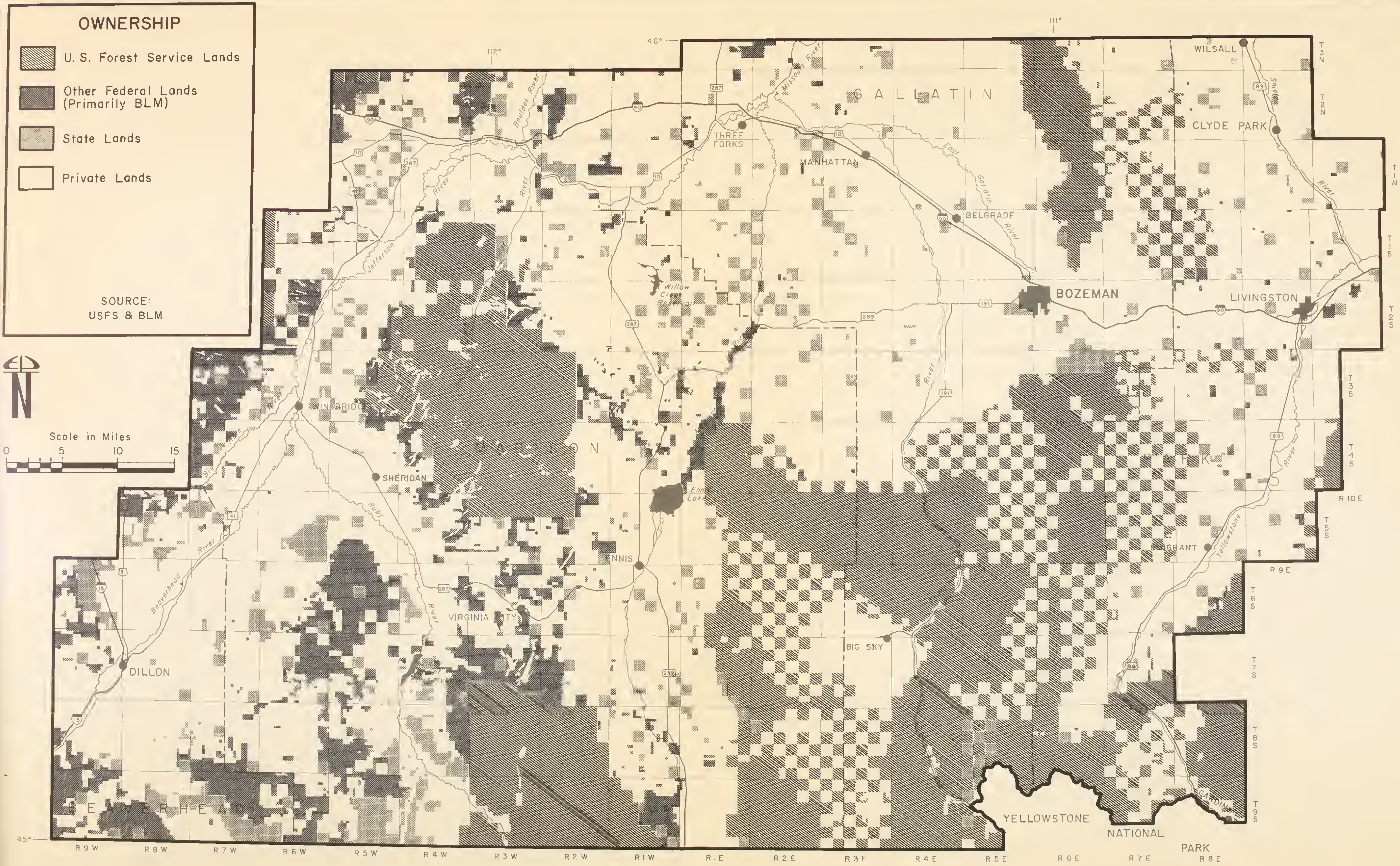
Land use generally depends upon land ownership and the regulations applied to it. Different rules and regulations apply to different lands, depending upon ownership; for example, publicly-owned land is administered in accordance with governmental regulations and policies for the benefit of the general public. On the other hand, the use of privately-owned land is dependent upon self-interest, property rights, and regulation law.

Location also partially determines land use. For example, outside of urban and residential areas, land use can depend a great deal upon physical characteristics of an area, such as climate, vegetation, topography, geology, and soils. The same factors may influence an area's ownership, but do not necessarily determine it.

There are three categories of land ownership within the Clyde Park-Dillon study area: federal,[3] state, and private. All are discussed separately below.

II.B.2. Federally-Owned Land

Approximately 50% of the land in the study area is federally-owned. Parts of six counties are included: Park, Gallatin, Madison, Beaverhead, Broadwater, and Jefferson (see Technical Appendix J for land-owner percentages).



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The study area includes large parts of the Gallatin and Beaverhead National Forests, administered by U.S. Forest Service offices at Bozeman and Dillon. The eastern portion of the study area, in Park, Gallatin, and Madison Counties, contains the largest portions of national forest land. It also includes most of the publicly-owned commercial forest lands in the study area.

The Bureau of Land Management (BLM) also administers a sizeable portion of land, which is predominantly in Madison County. Land administered by the BLM and the U.S. Bureau of Reclamation is classified on the Land Ownership map in the "other federal lands" category.

II.B.3. State-Owned Land

State-owned land in the study area is primarily administered by the Department of State Lands. This non-forested land is scattered throughout the study area as a consequence of the Enabling Act, granting the 16th and 36th sections of each township to the State of Montana. State forests are administered by the Department of Natural Resources and Conservation. The Fish and Game Commission controls game management areas, fish hatcheries, fishing access sites, state parks, monuments, and recreation areas. A small amount of land is owned by the Department of Institutions, the Department of Agriculture, and the State's university system. Wherever large continuous tracts of land are owned by the Forest Service, State lands are often clumped nearby as a result of land exchanges.

II.B.4. Privately-Owned Land

Approximately 4,941,728 acres (SCS 1970) of land in the counties of which the study area is a part are controlled by private corporations and individuals. The major corporation owning land in the study area is Burlington-Northern Railroad. When the railroads were constructed in Montana in the late 1800's, alternate sections of land along the railroad rights-of-way were granted to the railroad. A checkerboard pattern is still evident in the eastern half of the study area; the Burlington-Northern land is interwoven with national forest land, and contains the bulk of non-public commercial forest.

Urban and built-up areas, mostly privately-owned, make up a relatively small portion of the total study area. They consist of about .7% (77,569 acres) of the land involved within the six counties included in the study area (SCS 1970).

II.C. Agricultural Land Use

II.C.1. Irrigated Cropland

Irrigated cropland is that acreage upon which water is applied by an adopted method on a recurring basis as an integral part of crop production.

It does not include land with water-spreading systems that depend upon run-off from shower activity. As seen on the map entitled "Existing Land Use - Site Patterns" (referred to as the Land Use map elsewhere in this section), irrigated lands are usually found along major river valleys and in flood plains, where water is readily available. The amount of irrigated land in the study area is increasing, as various state and federal irrigation systems help eliminate pollution from return flows, reduce the quantity of water diverted from streams, and improve irrigation efficiency and crop production. However, irrigation requires large unobstructed tracts of land for efficient operation.

Irrigated land produces grains, row crops, pastures, and an increasing amount of hay. Average yields per acre for both irrigated and non-irrigated cropland are summarized in Technical Appendix J. Acreages of irrigated and non-irrigated cropland for each of the counties within the study are also given in Technical Appendix J.

The total acres harvested in the study area varies from year to year depending on climate and market status. For example. figures from 1973 show a drop in acres harvested and less yield on all croplands than in 1971. The reason is that in 1973 the average precipitation was 1% below normal, and in 1971 it was 22% above normal (MSU Extension Service). Obviously, the 1973 figures are more typical data (see Technical Appendix J).

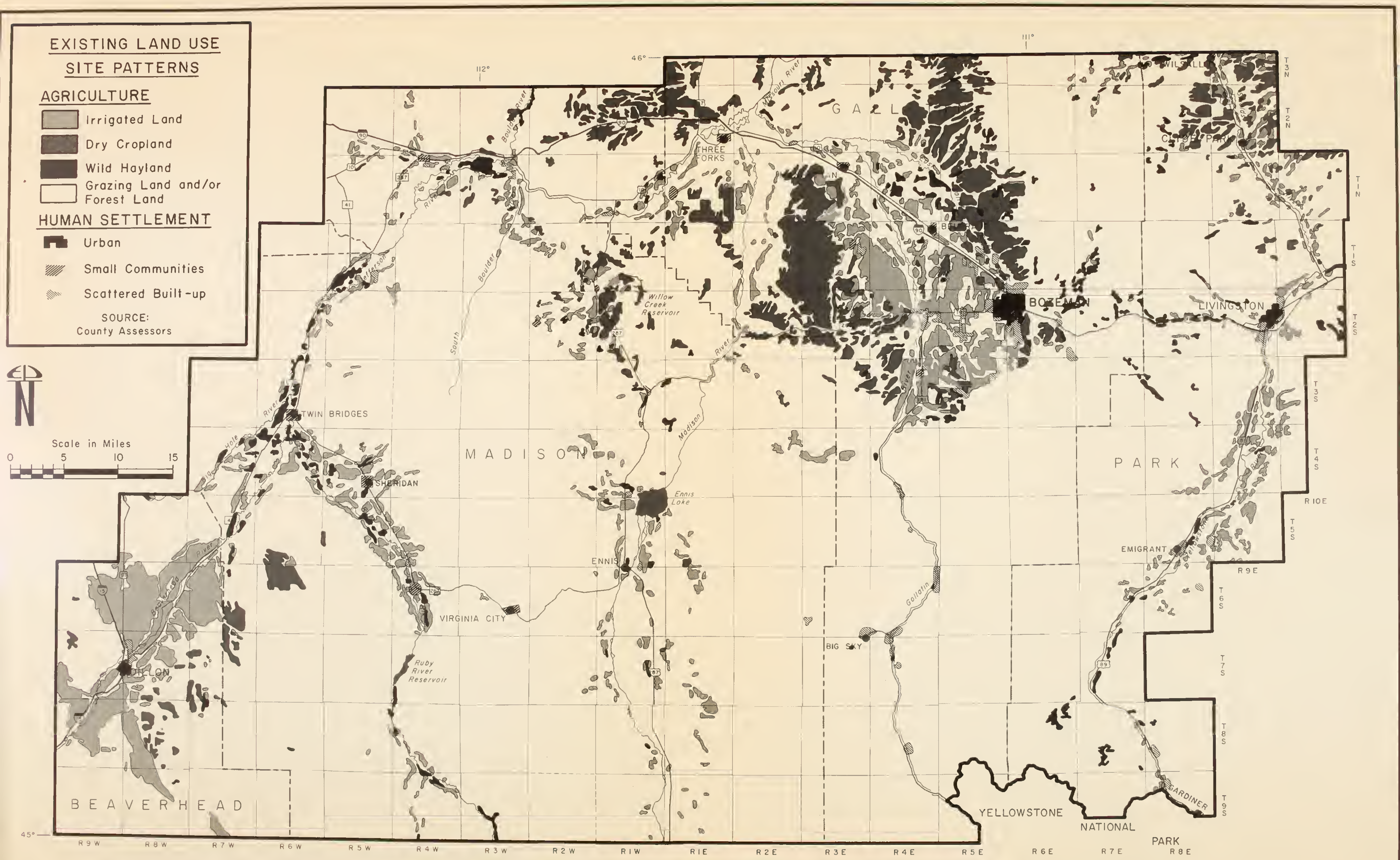
The market value of crops produced on irrigated lands between 1971 and 1973 increased by two to three times, largely because of increases in grain prices (Statistical Reporting Service - USDA).

II.C.2. Dry Cropland

Dry cropland is acreage which receives no supplemental water on a recurring basis. The most important grain produced in the study area on dry cropland is wheat, followed by barley, and then oats. Dry cropland dominates three regions in the study area: (1) northern Gallatin County, northwest of Bozeman, just off the west flank of the Bridger Mountain Range; (2) northeastern Gallatin County in the Madison plateau area, between Logan and Anceney on the north and south, and between Amsterdam on the east and the Madison River bluffs on the west; and (3) the Clyde Park and Wilsall area in north Park County.

The dry cropland areas shown on the Land Use Map include summer fallow. This is land left idle during alternate years to restore moisture; summer fallow is necessary to make crop yields profitable in a semi-arid climate. Strip farming, the practice of leaving alternate strips of land as summer fallow during alternate years, is prevalent throughout most of the study area.

Kinds of crops and average yields for counties within the study area are shown in Technical Appendix J. As indicated, grain production within the study area is decreasing as more cropland is converted to forage production (hay and pasture).



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II.C.3. Wild Hayland

Wild haylands are non-cultivated lands with a potential of at least one cutting of hay each year. They are usually adjacent to irrigated bottom lands or are on terraces not being used for dry cropland. The bottom and terrace lands used for wild hay are generally not suitable for cultivation; there is either too much or not enough moisture.

Bottom lands used for wild hay are too moist for cultivation in the spring, but are dry enough by late summer to cut hay with machinery. Vegetation found on bottom lands and used for wild hay includes (by common names):

1. tall reedgrass
2. American mannagrass
3. slender wheatgrass
4. tall sedges
5. bearded wheatgrass
6. basin wild rye
7. Kentucky bluegrass

Terrace lands used for wild hay are generally too dry for dry cultivated crops. The following varieties of vegetation are found on terrace wild haylands in years when the precipitation is approximately 10 to 15 inches (by common names):

1. bluebunch wheatgrass
2. needle and thread
3. western wheatgrass
4. thickspike wheatgrass
5. green needlegrass
6. junegrass
7. pou sandbergii
8. columbia needlegrass

Wild haylands may be under irrigation. When they are, the varieties of vegetation may change because of the increased moisture.

II.C.4. Grazing Land

There are three types of grazing land in the study area: pasture land, rangeland, and grazed forest land. Following is a description of each one.

Pasture land is land that produces forage; plants that are grazed, not cut for hay. Pastures consist of both irrigated and dry lands and are not included in the rotation with other land uses.

Rangeland is land upon which the natural plant cover is principally native grasses, forbs and shrubs having less that 10% tree canopy. It includes high mountain meadows with natural wet land vegetation, which may consist of willows, sedges and forbs. In some areas, there is a considerable amount of rangeland being irrigated. Under irrigation, the species composition of a rangeland is often changed to that of a wet land, but the forage produced is still primarily native species. Rangelands are used for grazing, and management is primarily achieved through the manipulation of livestock.

Grazed forest land is commercial and noncommercial forest land that has an understory of grasses and/or forbs, and is grazed by domestic livestock.

Pasture and rangeland statistics for the counties in the study area may be found in Technical Appendix J. Livestock production is also summarized for the six counties in Technical Appendix J.

II.D. Urban and Residential Land Use

II.D.1. Urban Areas

Urban areas are defined as those areas which have a population of 2500 or more (see site pattern delineations on Land Use map). There are three urban areas in the Clyde Park-Dillon study area: the cities of Bozeman, Dillon and Livingston. Bozeman, the largest, with a 1970 census of 18,670 had a growth rate of 39.7% from 1960 to 1970. Dillon had a 1970 census of 4,548 and a substantial growth rate of 33.3% from 1960 to 1970. Livingston, with a 1970 census of 6,883, had a growth rate of negative 16.4%

Bozeman is one of the fastest growing communities in Montana, and the fastest growing urban center in the study area. Good transportation facilities, a prime recreational location, and the presence of Montana State University have all contributed to the population growth.

The increased growth rate in Dillon from 1960-1970 may have been partially caused by a reduction in Beaverhead County's rural population. Dillon is Beaverhead County's trade, farm, and service center, and is also the home of Western Montana College.

Livingston lost population at a rate of 16.4% from 1960-1970. The cause can generally be attributed to cutbacks in service and production in the railroad and lumber industries in the area. Livingston is Park County's local trade and service center.

Based upon population growth alone, Bozeman and Dillon are the two urban areas which demonstrate a potential need for more electrical power.

II.D.2. Small Communities

Small communities are defined as those areas which have populations of between 100 and 2500. There are 18 small communities in the study area, which range in size from 100 to 1188 residents. According to the 1970 census, the total population of the small communities is 8338, or 27.3% of the total urban population.

The small community generally serves as a local center for commerce, entertainment, and limited services. Most of these communities are located in river valleys adjacent to transportation systems.

Small communities serving as local trade centers for their own people are also customers for the larger urban areas, in terms of wholesale trade.

The transportation, communication, and power networks that connect small communities to the larger urban areas are important lifelines. They enable residents to commute to larger urban areas for work, education, services and trade.

II.D.3. Scattered Built-Up Areas

Scattered built-up areas consist of any congregation of greater than 10 houses per square mile (not included in small communities). On the Land Use map, these areas have been delineated.

Urban growth is somewhat responsible for the existence of scattered built-up areas. People who move near urban areas to find jobs, but who are dissatisfied with urban or suburban life styles, tend to congregate in scattered built-up areas within commuting distance of cities. These residences generally take the form of rural subdivisions or trailer parks, and usually result in an unplanned, residential area within a natural and agricultural setting.

Despite zoning laws and subdivision regulations, the amount of land subdivided within the study area is increasing (see Technical Appendix J). This growth is of increasing concern in the communities and to planning boards at the state and county level. According to the Environmental Quality Council: "Demands for schools, sewers, storm drains, police and fire protection, municipal water supply, road upgrading and maintenance and public facilities are obvious public costs."[4]

II.E. Recreational Land Use

A combination of many features described in this section make the Clyde Park-Dillon study area a significant national recreational use area. Contributing features are proximity to Yellowstone National Park and land which is 50% federally-owned, supplemented by a great deal of scenic mountainous topography intersected by numerous streams and rivers (see geological inventory, section 6.3.2.2.). Most settlements are congregated into dense dispersed pockets; and because of its physiographic and climatic variety, the study area supports a wide diversity of plant and animal species (see sections 6.3.2.4. and 6.3.2.5.).

The prepared Recreation map indicates heavily-used activity areas, such as: (1) campsites, (2) picnic grounds, (3) fishing access sites, (4) state parks, (5) ski areas, (6) fairgrounds, and (7) golf courses. These areas are usually maintained by public agencies for public use. Most privately-owned recreational sites, e.g., dude ranches, private campgrounds, resorts, etc., are not delineated because complete information is not available. The Historic and Archaelogic map indicates locations of historical and archaelogical importance.

Other forms of recreation or sites not delineated on the Recreation map or the Historic and Archaelogic map are discussed along with those that are delineated because of their importance to the study area. The area has a great diversity of recreational opportunities, and similar activities are grouped together into broad categories listed below.

II.E.1. Parks

There is one state park in the study area, Lewis and Clark Caverns. State park sites were established to preserve certain natural features and to provide recreational facilities.

II.E.2. Campsites

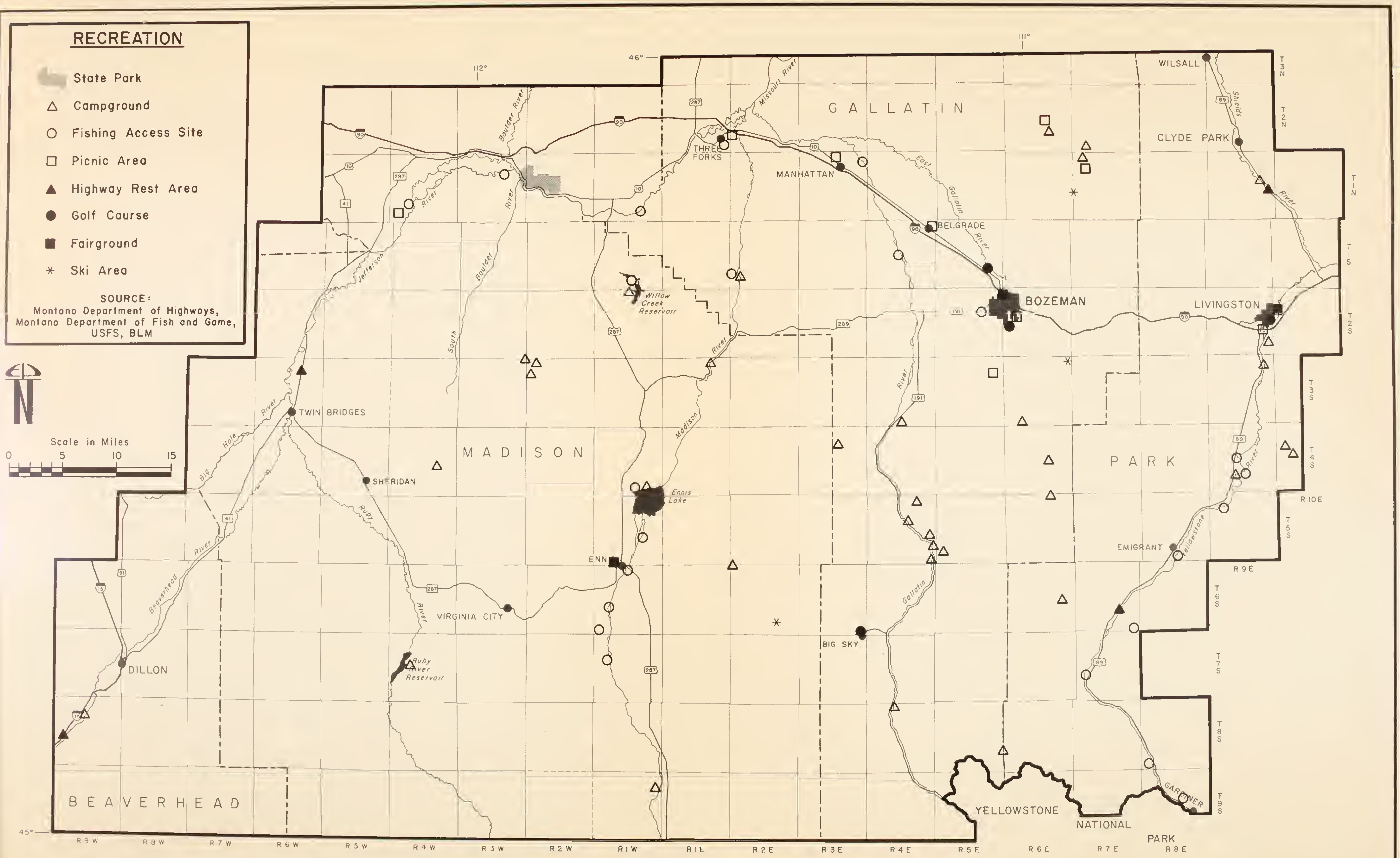
Included on the Recreation map are designated campgrounds administered by public agencies. Many of the approximately 35 public campgrounds are multi-purpose recreation areas, also offering fishing and hiking, and are usually associated with large acreages of publicly-owned land, such as national forests. Private campgrounds are not mapped because of lack of information, but should be considered equally as important as public campgrounds when present. In 1972, camping accounted for 3.6% of time spent on recreation by adults in Montana, and 4.7% of time spent by children; camping is also partially responsible for attracting out-of-state tourists, who spent 241 million dollars in Montana in 1973 (highway promotion unit).

II.E.3. Other Nature-Oriented Terrestrial Activities

This category includes specific nature-oriented, terrestrial recreation and locations not covered in the parks and campsites categories. The natural environment is the prime determinant of the quality of this form of recreation, and is an integral part of the success and pleasure of the activity pursued. Examples include picnic grounds, rest areas, scenic vistas, ski areas, horseback riding facilities, and designated hiking, skiing, and snowmobile trails.

II.E.4. Other Culture-Oriented Terrestrial Activities

Culture-oriented terrestrial recreation not mentioned in II.E.1. and II.E.2. belongs in this category. The condition of the site itself determines the quality of recreational activities pursued: baseball fields, tennis courts, golf courses, museums, and fairgrounds.



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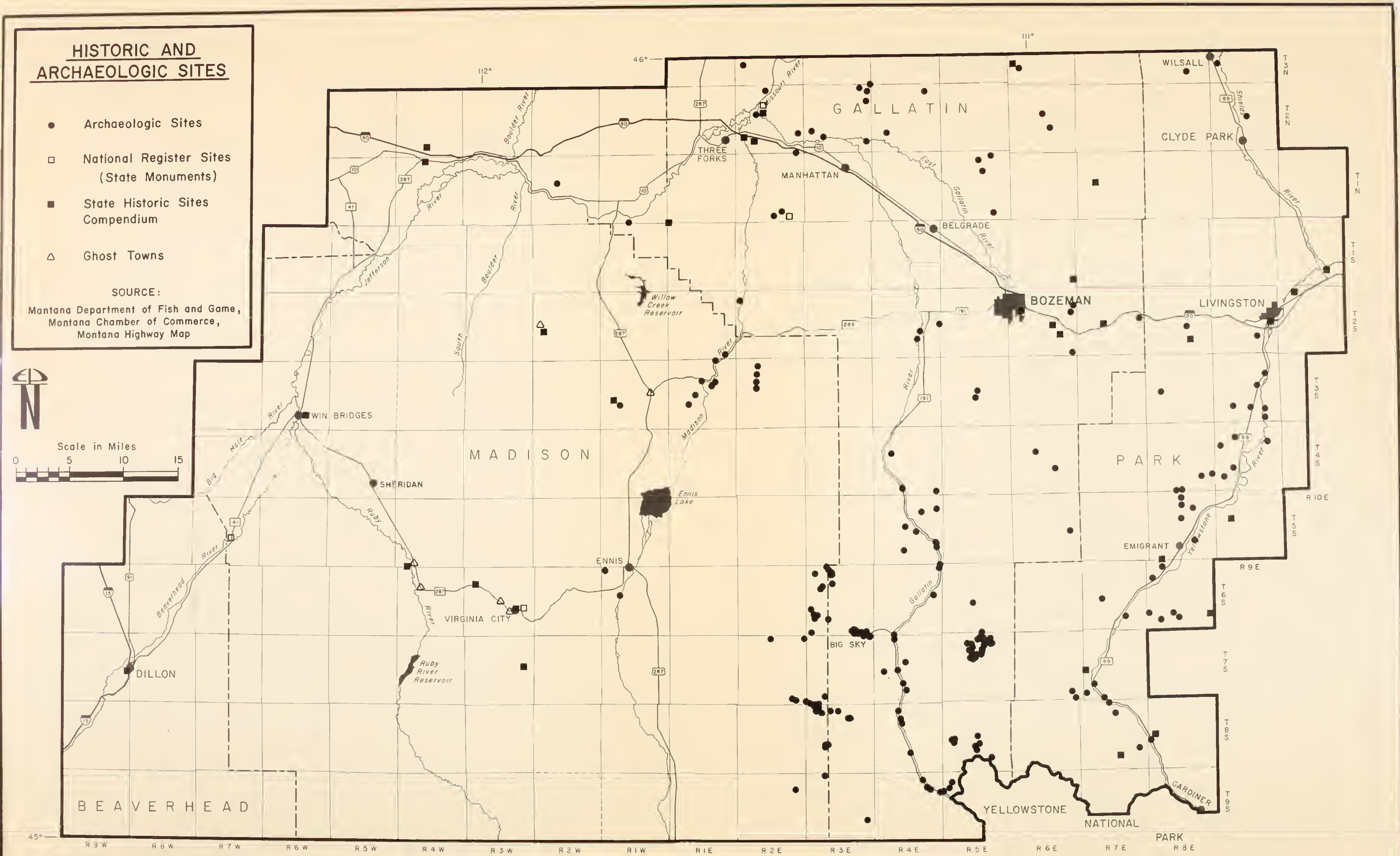

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II.E.5. Other Water-Related Activities

Other water-related activities are those which depend upon the presence of water, and are not included in II.E.1. and II.E.2. This category includes fishing access sites, boat ramps, swimming areas, marinas, and recreational areas for swimming, boating, and fishing. Prime fishing areas are listed in Technical Appendix J; classifications and methods used to classify fishing areas are also found in Technical Appendix J.

A portion of the Yellowstone River runs within the study area, and is a potential addition to the U.S. wild and scenic rivers system under the National Wild and Scenic Rivers Act of 1968. Part of the Madison River above Ennis is also a potential candidate (National Outdoor Recreation Plan).

II.E.6. Point-of-Interest Sites

Ghost towns are one of the more popular destinations for Montana residents who drive for pleasure. According to the Montana Statewide Recreation Plan, driving accounts for 18.4% of all recreation time. Most other points of interest involve geologic interest sites, fossil locations, gem fields, mineral locations, and near-pristine areas.

II.E.7. National Register of Historic Sites

The National Register of Historic Sites was created in response to the National Historic Preservation Act of 1966, an "act to establish a program for the preservation of national historic properties throughout the nation and for other purposes" (Federal Register). Criteria used to evaluate a site can be found in Technical Appendix J.

There are four historic sites in the study area that are listed in the National Register of Historic Sites: Madison Buffalo Jump, Missouri Headwaters, Beaverhead Rock, and Virginia City Historic District (see Figure 6-19). The Madison Buffalo Jump and Missouri Headwater Site are also state monuments.

Locations listed in the National Register are protected by the National Environmental Policy Act (NEPA) of 1969. Accordingly, an environmental impact statement must be filed before any change or alteration can be incurred upon any designated historic sites.

II.E.8. Other Historic Sites

Sites which have played significant parts in regional, state and local history, not included in II.E.8., have been mapped; those of established merit are listed in the Montana Historic Sites Compendum (1974). Others await further study.

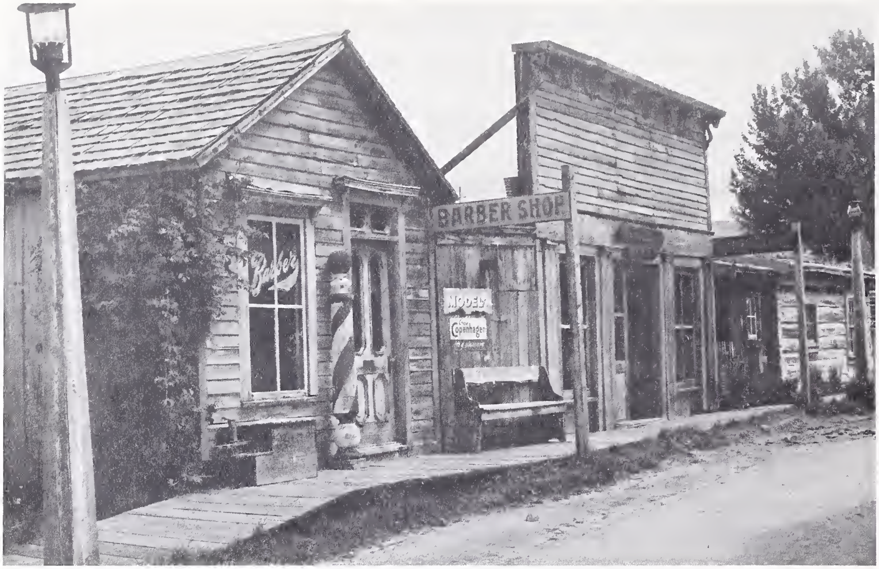


Figure 6-19. The study area contains a flavor of the historic past around the Virginia City Historic District.

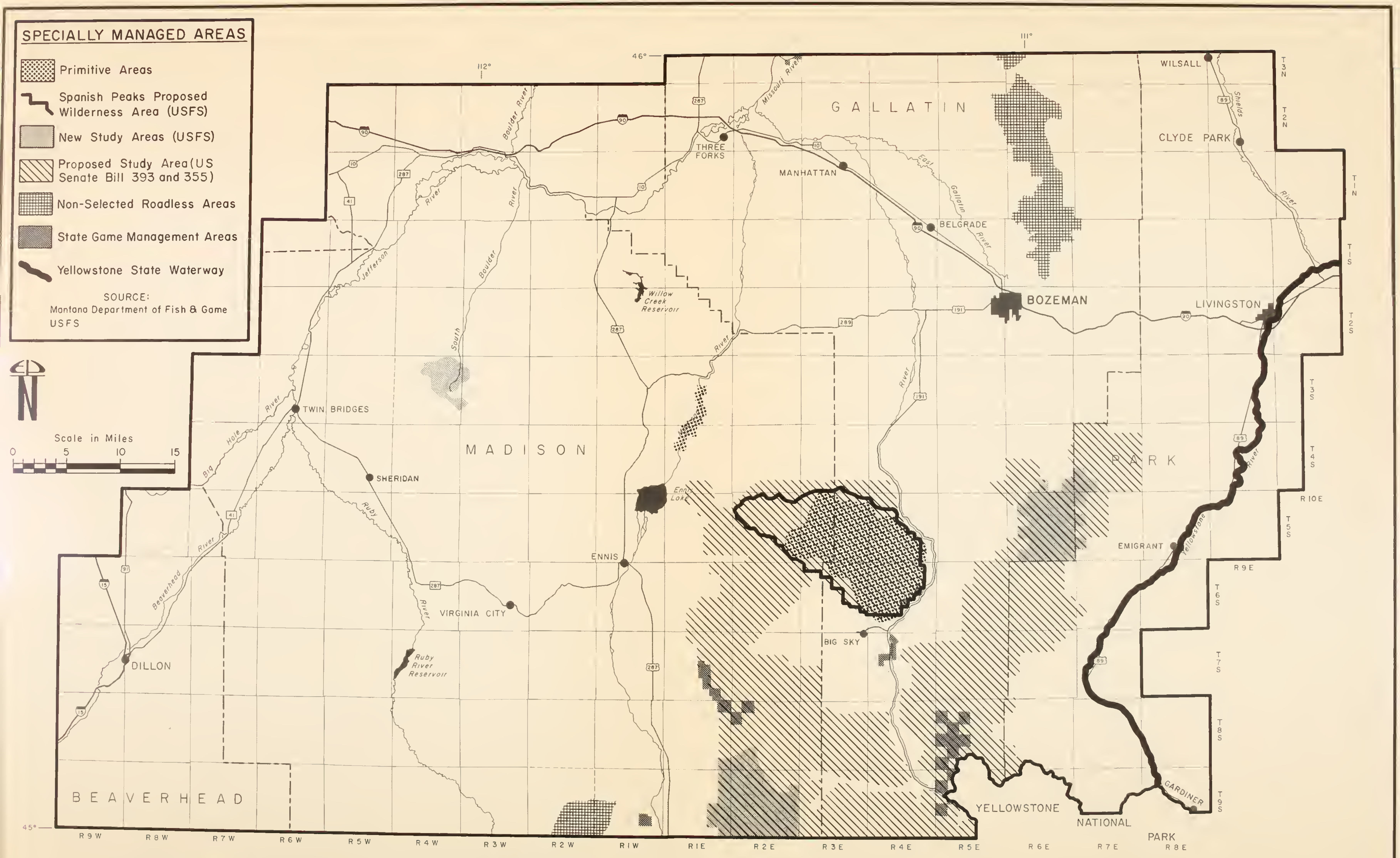
II.E.9. Archaeologic Sites

Approximately 216 archaeological sites were documented in this inventory, representing sites that have been investigated and those that are known and awaiting further study. Sites have been identified from Montana State University files (Gallatin Canyon Study), the National Register, and The Montana Historic Sites Compendum. To prevent unauthorized scavenging, these sites have been identified only by the section in which they occur.

II.E.10. Dispersed Recreation

One of the most important considerations of recreational land use concerns public lands, such as national forest lands, lands administered by the Bureau of Land Management, and others. They attract large numbers of people who pursue a wide variety of dispersed recreation. Unlike site-located or site-determined recreation, dispersed recreation (i.e., hiking, backpacking, cross-country skiing, hunting, and horseback riding) is difficult to inventory. It is impossible to enumerate the total number of visitor days with any precision, but the Montana Statewide Outdoor Recreation plan states that:

> In Montana, one of the outstanding characteristics of the present day recreational use is the pronounced increase in dispersed recreation activity. Today's recreationist is no longer content, if he ever was, with the recreational



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opportunity provided on an isolated tract or on park lands of small size. While these existing designated sites will continue to be used, especially associated with water resources, the recreationist has expanded his horizons and now roams far and wide on the public lands in search of new opportunity.

When considering the diversity of outdoor recreation available in the study area, the total physical, social, and economic picture must be kept in mind. The total profile may be seen in the state recreational goals found in Technical Appendix J, providing general guidelines for outdoor recreation in the study area and Montana in general. Section II.I.2.b. provides two quotations from the Bureau of Outdoor Recreation regarding outdoor recreation on a national basis.

II.F. Specially Managed Areas

Specially managed areas (see map entitled "Specially Managed Areas") include wilderness areas, primitive areas, new study areas, non-selected roadless areas, game management areas, and citizen-proposed study areas designated by Senate Bills 355 and 393. All of these categories have land use constraints limiting consideration as possible routes for transmission line corridors. Consideration is limited because specially managed areas represent areas which are: (1) legally protected against alteration of their natural conditions, (2) specifically managed according to detailed land use plans, or (3) specially managed, pending completion of detailed land use plans.

II.F.1. Primitive Areas

The Clyde Park-Dillon study area includes two areas classified as primitive: Beartrap Canyon, administered by the Bureau of Land Management; and Spanish Peaks, administered by the U.S. Forest Service (USFS).

The Bear Trap Canyon area is administered under Title 43, Revised Federal Codes (C.F.R.), Part 6220. Any changes in use of the area not prescribed by the Wilderness Act of 1964 must be preceded by a study and an environmental impact statement, with the final decision made by Congress. However, the process would be too time-consuming for the purposes of the present study.

The Spanish Peaks primitive area is presently being considered by Congress for wilderness classification under the National Wilderness Preservation Act of 1964, as recommended by the U.S. Forest Service in 1967. Approximately 63,300 acres of national forest land are involved. Until Congress reaches a decision, the area is protected the same as an existing wilderness area. Under the National Wilderness Preservation Act of 1964, logging, road building, motorized travel, and the construction of permanent installations such as transmission lines are prohibited in classified wilderness areas. In order for a transmission line to be routed through an area presently classified as wilderness, or through a primitive area being studied for wilderness classification, that portion of the area would need to be declassified by an act of Congress, or be authorized by the President of the United States as necessary for public interest. This would probably be done only in case of a national emergency. In any case, the criteria for declassification and the period of time involved are such that, for purposes of the present study, the Spanish Peaks area can be excluded from short-term consideration as a possible route for the proposed 161-kV Clyde Park-Dillon transmission line.

II.F.2. New Study Areas

New study areas, shown on the Specially Managed Areas map, are national forest lands which have been selected by the USDA forest service to be studied for possible recommendation to Congress as additions to the National Wilderness Preservation System. The study area includes three new study areas: 79,000 acres in the Taylor-Hilgard area; 5,820 acres in the Tobacco Roots middle mountain area; and 22,268 acres in the Hyalite area.

The wilderness characteristics of new study areas are protected until detailed studies can be completed and a land use recommendation can be reached. Before any permanent installations such as transmission lines can be allowed to cross a new study area, a detailed land use study must be prepared and presented as a public environmental impact statement. In the statement, alternatives to classifying the area as wilderness must be considered. Again, the amount of time involved in preparing these studies is too great for consideration of new study areas as possible routes for the proposed facilities.

II.F.3. Non-Selected Roadless Areas

Certain roadless areas not designated as new study areas by the USFS have been classified as non-selected roadless areas (see Specially Managed Areas map). In order to consider a non-selected roadless area for a transmission line corridor, an environmental impact statement would have to be prepared by the USFS. The USFS Manual, Title 8200 - Land Use Planning, Subtitle 8262.1 - Management states that: ". . . no action will be taken that will permanently change the wilderness character until an environmental statement has been completed and wilderness values within roadless areas have been condsidered."

II.F.4. Game Management Areas

Game management areas are also specially managed (see Specially Managed Areas map). They are controlled by the Montana Fish and Game Commission (MFGC), and managed to protect critical game habitat (primarily elk winter range).

Besides the considerable amount of land owned by the MFGC, land for game management areas is leased from federal agencies and private land owners.

In order to allow a transmission corridor to cross land owned by MFGC, permission would need to be obtained from that agency for an easement; other lands would require easements from the individual land owners or administrative agencies (Brown 1974). Also, other legal action would need to be taken for lands deeded from the Nature Conservancy, a private conservation group.

II.F.5. Citizen Proposed Study Areas Designated by Senate Bills 355 and 393

Three areas in the Clyde Park-Dillon study area were chosen to be studies for wilderness classification by proposed Senate Bills 393 and 355. Senate Bill 393 specifies the 163,000 acres of the Hyalite-Porcupine-Buffalo Horn area, and the 240,000 acres of the Taylor-Hilgard, area. Senate Bill 355 proposes an extension of 113,102 acres in the Spanish Peaks area. Until legal decisions are made regarding Senate Bills 393 and 355, the policies and laws currently governing the areas under study remain in force. Therefore, at the present time the land use of these proposed study areas will depend upon the planning or policy of the U.S. Forest Service.

To ensure the maintenance of wilderness areas, a plan is outlined in the Nationwide Outdoor Recreation Plan, "Outdoor Recreation - a Legacy for America":

> To ensure the availability of wilderness recreation to all Americans, the Administration will seek an amendment to the Wilderness Act to allow at no Federal expense for wilderness designation and management by non federal interests lands that meet wilderness criteria and are administered by states, localities, or private interests.
>
> The Administration will also seek an amendment permitting the U.S. Forest Service to recommend wilderness designation of areas affected by man, that have returned essentially to a natural condition, in the eastern portion of the country.
>
> To broaden the base for potential wilderness type experiences, all Federal land managing agencies will identify within three years of the date this plan is submitted to Congress, areas under their administration which should be considered for wilderness or wild status.
>
> All public and private land managing agencies should designate and protect small areas suitable for wilderness experiences. The pocket wilderness concept - implemented by all levels of government and private landholders - could expand greatly the opportunities for many more Americans to enjoy a wilderness-type experience.

The proposals outlined in the Nationwide Outdoor Recreation Plan deserve the same consideration given to existing land uses, and help to point out the alternatives available in maintaining wilderness areas.

II.G. Unmapped Land Use Categories

II.G.1. Woodlands

The largest tracts of woodlands in the Clyde Park-Dillon study area are on national forest land, followed by private corporation land, and ranch land. These woodlands are of two kinds: commercial forest (capable of producing crops of industrial wood), and non-commercial forest (incapable of yielding crops of industrial wood). A brief discussion of each kind follows.

Commercial forests prevail over much of the study area, and the harvest of commercial timber is quite important to the economy of the Clyde Park-Dillon region. Data related to timber found in commercial forests in the study area, such as average annual harvest, species, composition, size, and stocking of forests are discussed in section 6.3.2.4. (vegetation).

While commercial forests are economically important to the study area, non-commercial forests consist of land stocked with species of trees with no commercial value or land which has been withdrawn from timber utilization.

Economics aside, woodlands (both commercial and non-commercial) are important for other reasons. Grasses and forbs (discussed in section 6.3.2.4.) which occur in the understory of woodlands are important sources of forage for cattle, especially in the western region. In addition, woodlands provide habitats for a large number of wildlife species (see recreation inventory in II.E. of this section and fauna inventory, section 6.3.2.5.).

II.G.2. Water Areas

Technical Appendix J indicates small water areas (i.e., ponds, reservoirs, and lakes) ranging in size from .2 to 40 acres, and perennial streams less than one-eighth-mile wide which occur within each of the six counties involved in the study area.

II.H. Linear Patterns

Maps have been provided for the following two linear pattern categories:

1) Existing Land Use - Linear Patterns - Transportation. The map shows transportation-oriented land use, which includes four-lane highways, two-lane paved roads, graveled and graded roads, unsurfaced and graded roads, primitive roads, designated trails (USFS), railroads, and airports. It is contained in the pocket on the back cover.

2) Existing Land Use - Linear Patterns - Utilities. For map and discussion, see Chapter Three.

The present pattern of corridors within the study area, shown on the two maps mentioned above, is a function both of the topography of the land and of the historic development of transportation and population centers in Montana. Comparison of these maps reveals that, in many cases, the same corridors are used simultaneously for a variety of linear structures, e.g., highways, railroads, pipelines, and power lines. This is because linear patterns are subject to similar site restrictions. The factors leading to the existing pattern of major corridors should be understood before any plan is implemented to impose a new corridor on the landscape.

The presence of existing corridors places certain restrictions upon other types of land use, and it is important to consider whether the impact of a new linear structure would be greater following an existing corridor or traversing a new area presently not crossed by a linear structure. Unfortunately, the areas most convenient for corridor location are often those best suited for other land uses, e.g., agricultural and residential, with which linear patterns may be incompatible.

II.H.1. Transportation

The present pattern of major transportation corridors in the study area emerged relatively early in the history of Montana. Early roads were restricted to valleys and to lower mountain passes. Population centers developed along these major corridors, especially after the introduction of the railroad to the study area.

II.H.1.a. Roads

next page also

The study area has only one major east-west highway corridor, Interstate 90, which crosses the north side of the study area from the Livingston valley westward to Whitehall, and continues on to Butte. Prior to construction of Interstate 90, U.S. Highway 10 followed the same general route with some local deviations. The remaining principal roads generally run in a north-south direction, semi-perpendicular to Interstate 90. The north-south pattern was pre-determined by six mountain ranges, structurally situated in a north-south direction.

U.S. Highway 191 is the main thoroughfare from Idaho northward through the study area. Other important routes are: U.S. 287, connecting I-90 with U.S. 191; U.S. 89, from Yellowstone Park northward to Great Falls; Montana 287, one of the main connecting east-west highways; and Montana 41, from Dillon to Whitehall. Settlement patterns and existing roads are directly related, in that most of the population centers are adjacent to the principal highways. The remaining county or local roads correspond to the valley floor areas around population centers. The potential for a more diverse road system is small because of topographic limitations and long distances relative to the number of people served.

The road delineations and classifications are on the Transportation Map.

II.H.1.b. Railroads

Railways are subject to the same restrictions that limit highway alignment; when present, highways parallel railroad corridors throughout much of the study area.

The major freight railway in the study area is the Burlington-Northern main line, which is followed closely by the Interstate 90 east-west corridor (see the Transportation map). A connecting line exists from Logan to Helena.

East-west passenger service is offered by Amtrak, which uses the Burlington-Northern tracks, and, therefore, the Interstate 90 corridor.

II.H.1.c. Airlines

The major airlines serving the study area are Northwest Orient and Frontier. Commercial service is available only at the Gallatin County airport. The Transportation map indicates the locations of airports with facilities, airports without facilities, and private airstrips.

II.H.2. Utilities

II.H.2.a. Electric Transmission Lines

Unlike transportation corridors, major high-voltage transmission lines need to connect only major load centers, and often cross upland benches in a straight line between generating plants and load centers, ignoring minor undulations in topography and agricultural use patterns. In the mountainous western portion of Montana, transmission line corridors usually follow the major highways (especially I-90 and I-15) because the problems of maintenance are more severe, but in some instances the lines cross forested mountain areas to minimize distance. Data on existing transmission lines found in the study area are discussed in Chapter 3.

II.H.2.b. Gas Pipelines

Pipelines carrying natural gas to population centers tend to follow the major transportation corridors discussed above.

II.I. Proposed/Potential Land Use

II.I.1. Linear Patterns

The Montana Highway Department (1974) plans no new transportation corridors through the study area within the next five years; construction outlined in its five-year plan is primarily maintenance or improvement of existing corridors. Manipulation of Federal Highway Trust Funds by the federal government has made road construction and maintenance uncertain in Montana.

II.I.2. Site Patterns

II.I.2.a. Agricultural Land Use

The amount of irrigated land in the study area is increasing, and much of the newly-irrigated land is irrigated by sprinkler systems. These are usually operated by gasoline or electric pumps, and the trend toward powered sprinkler irrigation is indicated in Technical Appendix J, which shows an accelerating increase in the rate of horsepower used by irrigation pumps.

(i) Dry Cropland. Some dry cropland is potentially irrigable and may someday be irrigated. The county acreages of dry cropland, and the value of the production from those acres for 1973 is inventoried in Technical Appendix J.

(ii) Wild Hayland. This category may decline because of cropland extensions, both irrigated and non-irrigated

(iii) Rangeland. There will probably be a decrease in rangeland in the future,[5] depending upon other possible changes, i.e., subdivisions, recreational use, and cropland extensions into existing rangeland.

II.I.2.b. Human Settlement Patterns

(i) Urban Areas. Expansion of urban areas brings a gain-loss concept insofar as land use is concerned. What may be gained is relative to the type of expansion taking place, whether it is for residential, industrial, or commercial purposes. A gain in one type of service might cause a deterioration in other services, e.g., an increase in laundry service may substantially increase the load on existing sewer facilities. Losses that are most direct include loss of agricultural land, wild game habitat and aesthetic values. Potential changes in land use depend upon how the above factors are weighted over time by local officials and citizen input.

The trend in the last ten years[6] has been one of growth in and around urban centers in the study area. Unless legislation changes the situation, urban land use should continue to expand into the hinterlands. Population projections are not easily made, but the Montana Highway Functional Classification and Needs Study of 1974 has estimated population and percentage changes from 1970 to 1990. The following chart indicates changes for the three urban centers in the study area. For Bozeman and the Gallatin

	Population Change 1970-1990	Percentage Change 1970-1990
(1) Bozeman	+13,862	76.4%
(2) Dillon	+ 1,490	32.0%
(3) Livingston	+ 800	11.3%

Valley, the potential growth may be very significant.

(ii) Small Communities. Most of the classified small communities in the study area lost population from 1960 to 1970, except Belgrade, Whitehall, Sheridan, and Twin Bridges, which all gained over 15% (U.S. Census). Out of this group, Belgrade has the best growth potential because of its proximity to the Gallatin County Airport, Bozeman, and the junction of Interstate Highway 90 and U.S. Highway 191.

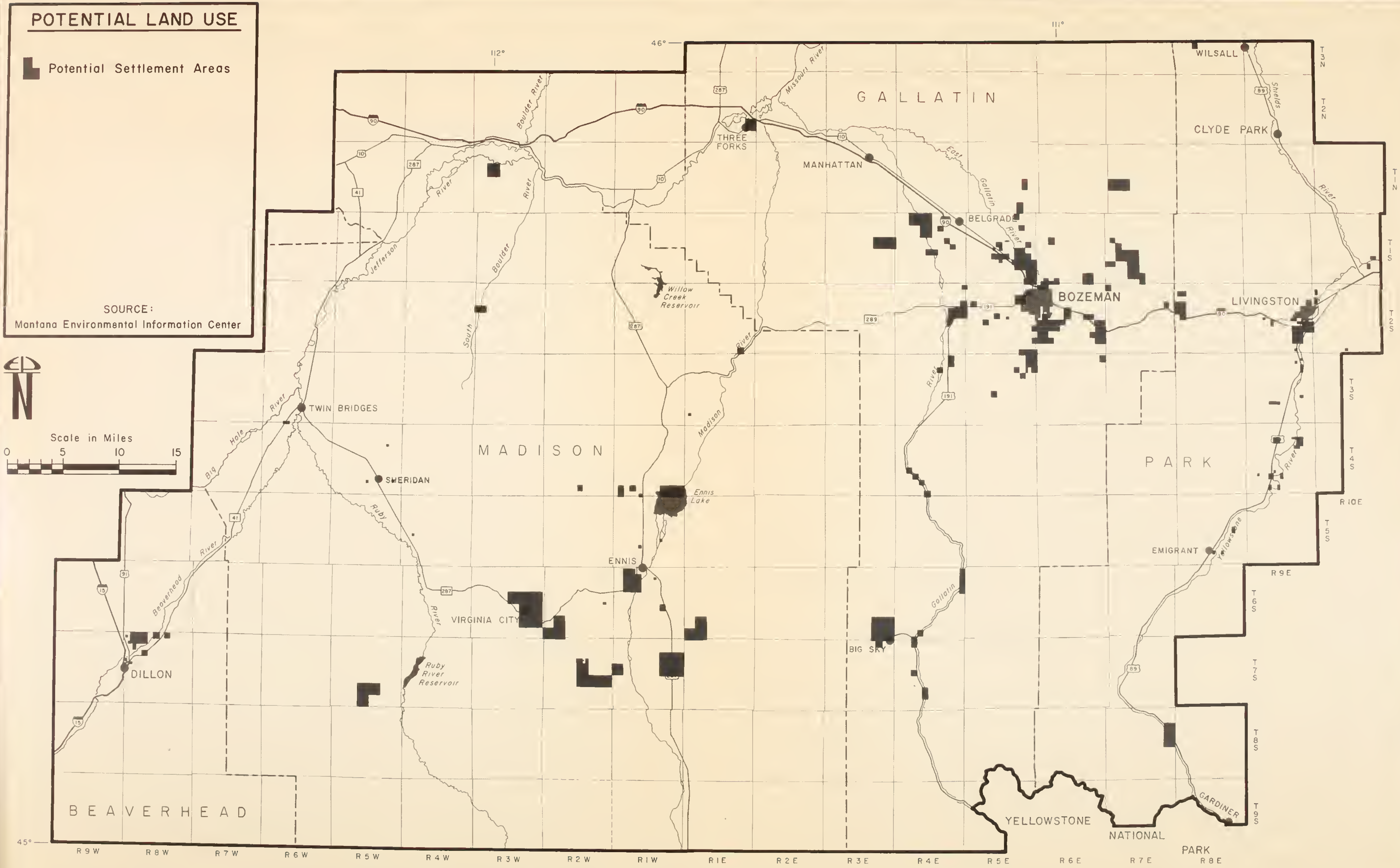
(iii) Scattered Built-Up Areas. The trends in urban growth discussed above also extend into this land use category. See section II.D., Urban and Residential Land Use, for a discussion relevant to this category.

(iv) Recreational Land Use. The potential for recreation is diverse in the study area. At this stage of development, either developed recreation (ski areas, summer homes, resorts, dude ranches, etc.) or non-commercial recreation (natural areas and their use, fishing, hunting, backpacking, cross-country skiing, etc.) could be enhanced in the future. Decisions will be made based upon the values and priorities set by government reaction and public opinion (see Figure 6-20).

The following two paragraphs are from the Bureau of Outdoor Recreation's National Recreation Plan, "Outdoor Recreation - A Legacy for America" (1973).

> Increasing Demand
>
> Through increased mobility, more leisure time, the greater affluence, new recreation vistas have opened to millions of people who had only limited opportunities to experience them in the past. Popular areas have become crowded, often to the point of diminished enjoyment. The traditional recreational management problems have become complex due to pressures of overuse and the need to install an environmental awareness and appreciation in multitudes of new recreationists.
>
> Recreation's Changing Patterns
>
> In addition to increased demand for recreation there have been substantial changes in people's recreation habits and patterns. For example, more people are now taking nonsummer vacations. Also, many recreation activities have been affected by technological change, because portable equipment and facilities now make possible instant, moveable recreation areas. Changes in recreation tastes are illustrated by the increased participation in legislature actions, voter supported bond issues, activity attendance, equipment sales, and the many citizen suggestions to recreation agencies.

POTENTIAL LAND USE



SOURCE:
Montana Environmental Information Center

CLYDE PARK—DILLON 161 KV TRANSMISSION LINE PROJECT **ENERGY PLANNING DIVISION, DNR & C 1976**

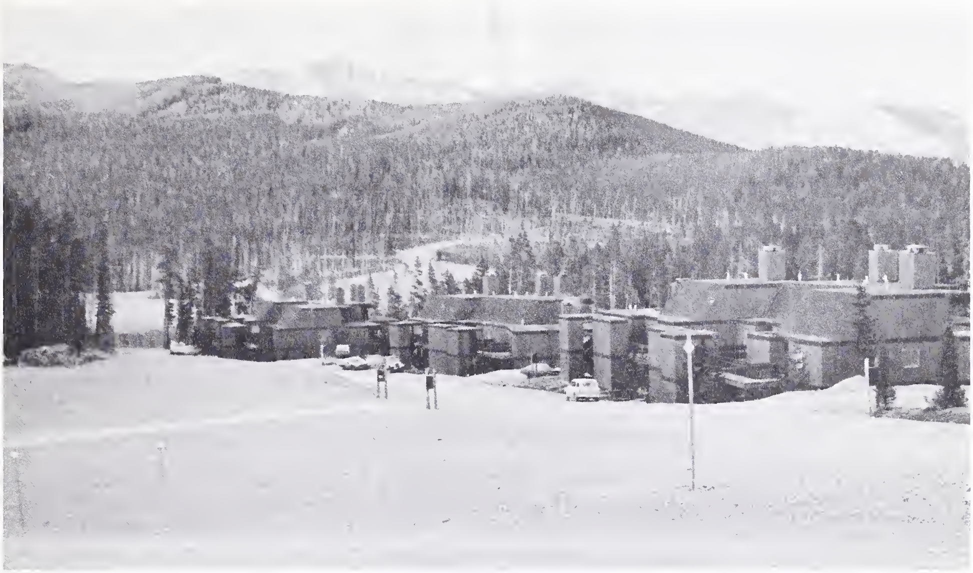


Figure 6-20. These condominiums represent the pinnacle in recreational development.

III. Impacts

The severity of potential transmission line impacts on land use depends upon the specific land uses, tower locations, construction technique used, existing vegetative ground cover, miles of access road generated, aesthetic impact of the corridor, and any resultant impacts on land uses of adjoining areas. The proposed line would include about 163 miles of 80-foot-wide corridor and 25 miles of 60-foot-wide corridor, thereby directly affecting 188 miles (1,762.42 acres) and indirectly affecting an unknown number of adjacent acres. There are two general types of impacts which would result from the proposed line: physical and attitudinal. The former indicates interference with agricultural practices, acres of potential erosion, etc; the latter represents the impact of transmission lines on public opinion, and resultant sociological behavior. Both types of impacts are significant, but physical impacts are more easily quantifiable.

III.A. Agriculture

As agriculture is Montana's most important industry (Montana Department of Agriculture 1974), the preservation of agricultural lands is essential. Impacts of transmission lines on agricultural lands are determined by site-specific locations of tower bases and guying cables, access road locations, and construction activity. Different impacts affect each type of agricultural land, and are discussed below.

III.A.1. Irrigated Lands

A transmission line would have no direct effect upon irrigated lands; however, the mobility of irrigation equipment could be impaired by the placement of poles and guying wires, possibly causing some lands to be reverted to non-irrigation or be taken out of production altogether. Maneuverability of farm equipment may be hindered; however, usually smaller equipment is used on irrigated lands than on dry lands. The construction phase would have minimal impact on irrigated lands because they are tilled only periodically, but could reduce crop production if the line were constructed during the planting, growing, or harvest season of any particular crop. A possible problem is presented by access road locations built in the construction process. Whether roads are temporary or permanent, they may promote unnecessary or unwanted use by persons other than the land owner or construction crew.

III.A.2. Dry Croplands and Wild Haylands

Possible impacts of a transmission line upon dry croplands and wild haylands are the construction period itself, unauthorized use of access roads, and inability to maneuver farm equipment. The scale of equipment used on dry land tracts is usually large and too cumbersome to maneuver around transmission line poles without hindering efficiency.

III.A.3. Grazing Lands

Grazing lands are vulnerable to the unauthorized use of access roads, decreasing the chance of preservation. A direct impact could be caused during the construction period by disruption of range and pasture procedures established by the land owner or user of the land.

Agriculture is extremely important in Montana and possibly the state's best long-term renewable resource. Preservation, development, utilization, and efficiency of agricultural lands should be weighed carefully when considering possible adverse effects.

Governor Thomas Judge stresses the importance of agriculture in Montana:

> Investments in agriculture already yield a greater proportionate return than do those in industry, and America has been losing its edge in technology to Japan, Germany, and other industrialized countries. In this time of serious food shortages and possibilities of widespread famine, a concentrated effort to increase our livestock and crop production is becoming much more than a wise move to improve our trade deficit, our dollar's stability, and our global relationships. It is becoming a moral obligation (Judge 1973).

In order to maintain Montana's tradition and priorities as a state with an agricultural economy, high yield agricultural lands should be protected against possible adverse impacts.

III.A.4. Mitigating Measures for Agricultural Lands

Avoidance of irrigated land is recommended; however, if crossing irrigated lands is unavoidable, poles should be placed when possible so that they will not interfere with sprinkler systems or equipment to operate ditch systems.

Many problem areas and land losses can be avoided by consultation with current land users in order to coordinate construction phases with agricultural needs. Access roads should be closed to public use.

III.B. Urban Land Use Impacts and Mitigating Measures

Impacts of transmission lines on urban land include possible interference with communication systems, audible noise, site-specific tower location interferences, and aesthetic influences. Also, as any other linear land use pattern, the line will define or divide urban spaces with possible sociological implications. Public reaction to a transmission line corridor in Billings in 1974 demonstrated the social concern about corridor location in urban areas; the negative reaction is indicative of the undesirability of the line in proximity to residential areas.

The addition of power line corridors to urban areas has the potential for positive as well as negative effects. The corridor as a linear element can be incorporated into future transportation circulation systems or linear park schemes, and heat from line loss may someday be harnassed. If used in conjunction with growth plan objectives of local planning authorities, corridors can direct urban sprawl to community advantage, but prior consultation and coordination is necessary.

Urban areas have traditionally been the most sensitive to the aesthetics of power lines due to the large number of persons affected. Larger population centers require the proximity of transmission lines to supply the collective demand; however, urban land use, represented by a vocal majority of the population, puts undue stress on surrounding land uses, represented by a smaller, rural population, for accommodating the corridor.

Possible mitigating measures for impacts upon urban areas can be seen in the following quote:

> The answer both to unsightliness and to vulnerability is, of course, to run utilities underground. This is being done in progressive communities, usually beginning with downtown areas and proceeding on a programmed basis along main thoroughfares and other locations where they may be offensive. Recent federal programs directed toward beautification of town and county have given an impetus to the drive to place utility lines underground (Frank So 1968).

III.C. Recreational Land Use Impacts

The necessity of and benefits gained from recreational use of the outdoors is described in the following quote:

> All these cultural advances - higher incomes, faster travel and more leisure time - have given us unsurpassed capabilities for using natural resources that refresh and inspire. Let us hope that our increased capacity to utilize them has been paralleled by a growing appreciation of their worth and a chosen few is not enjoyed by many, and the more numerous clientele should assert a proportionately stronger influence. The more there are who enjoy a resource, the more champions there ought to be to defend it.
>
> The promotion of human well-being is an object of all conservation, and the 'athletic-aesthetic' resources contribute very directly to this program. They are not essential in the same sense as water and soil, but they enrich even further a people possessed of abundant water and fertile soils. They make of men better conservators by strengthening values. Outdoor recreational resources improve the bodies of persons who enjoy them, thereby fitting such persons for greater application to their work and more constructive citizenship generally. The same healthful relaxation promotes mental alertness as well, soothes frayed nerves, and makes of the participant a more agreeable associate (Parson 1972).

Recreational land uses can provide economic benefits as well as aesthetic rewards. Estimates of recreation expenditures in Montana in 1971 range from $91,850,000 to $210,460,000 (U.S. Forest Service, Beaverhead National Forest), depending upon which activities are classified as recreation and which are considered tourism. Approximately 70% of this amount is spent by out-of-state recreationists. Obviously, recreation does bring a substantial amount of money into the state, and will probably be even more important in the future, as expressed below:

> All outdoor recreation activities in the region (Beaverhead National Forest area) are expected to continue to increase in the future. Although there are indications that dispersed camping is becoming more popular, the sale of recreation vehicles continued at a relatively high rate until the announcement of fuel shortages. Sales of these vehicles should drop noticeably in the next few years and again increase along with available fuel. Finding adequate dispersed and developed parking and camping sites near the recreation areas may pose a problem in the near future. Hunting and fishing activity is expected to continue to increase at a relatively high rate (U.S. Forest Service, Beaverhead National Forest).

III.C.1. Site-Specific Recreational Impacts

Site-specific impacts caused by transmission lines, other than visual impacts, are indirect when considering recreation per se. Transmission lines usually do not cause an individual to stop camping in a campground, fishing in a stream, floating on a river or picnicing at a picnic area. The most important impact may come from the alteration of a person's expectation of what he will see (see Aesthetics in section 6.3.3.5.).

The indirect impacts of a transmission line on recreation may be both positive and negative; what is positive to one person might be negative to another. For example, loss of tourists or recreationists through indirect reaction to the visual impact could help preserve the area's natural resources longer, but may not preserve the present commercial/tourist economy of the area, especially the heavily used areas (see Recreation map).

Development of recreational opportunities may be expanded by the addition of electricity sources. Possibilities include ski areas, dude ranches, condominiums, bars, lodges, summer homes, campgrounds, and other commercial and private configurations. As a result, more natural resources would be used, causing problems which may ultimately downgrade the attractiveness of the area. This concern can be expressed by the following quote:

> The establishment of the large and well publicized Big Sky Resort and recreation complex has a potential for attracting enterprises of a similar nature to the noted Gallatin Canyon area. While private enterprise can and does serve a very important role in providing for the needs of the recreationist, the potential for ultimately lessening the attractions of the region through uncontrolled growth must be noted also. Experiences elsewhere in the nation with the aftermath of intensive development in prime recreational areas merit the attention and vigilance of all concerned (F&G Statewide Outdoor Recreation Plan).

III.C.2. Mitigating Measures

If possible, avoid at a reasonable distance (one-half mile) such recreational areas as campgrounds, picnic areas, parks, and other site-specific areas applicable to recreation.

The Bureau of Outdoor Recreation strongly recommends the use of underground utilities in outdoor recreational facilities (Mayer 1975).

III.D. Dispersed Recreation

Impacts on dispersed recreation are more difficult to assess than specific site locations. The transmission line may cause at least two direct impacts: (1) visual (see Aesthetics in section 6.3.3.5.) and (2) access utilization of the line's corridor. Dispersed recreation generally takes place on public lands, which provide a wide variety of outdoor recreation opportunities for the public.

Generally, public lands have restraints on existing road use and off-road vehicular traffic. Providing a transmission line corridor through an area of public land may introduce motorized traffic in the form of four-wheel drive vehicles, motorcycles, or snowmobiles. Non-motorized travel, such as horseback riding, walking, or skiing may also be promoted in a previously inaccessible area by the general recreationist. Hunters may take advantage of the corridor and increase pressures on wildlife and game management (see Fauna in section 6.3.2.5. Also, see comment on dispersed recreation taken from the Montana Statewide Outdoor Recreation Plan in the recreation inventory in section II.E.10.).

Added access to public lands may be considered either negative or positive. Some persons may consider it an adverse impact, while developers may consider it good or necessary. However, there is a wide range of attitudes between the two viewpoints of negative and positive impacts. The decision is a subjective one, depending upon individual viewpoint.

6.3.3.3. Economy

I. Introduction

The purpose of this section is to examine the fiscal presence of the proposed transmission facilities. Information provided by the applicant was reviewed and compared with leading economic indicators in a four-county study area (Beaverhead, Madison, Gallatin, and Park Counties). This evaluation primarily focused upon the transmission line's impact upon employment, income, taxes, and rates, all of which are discussed below. It became apparent that the small scale of the proposed projects would result in economic impacts on a corresponding minor scale.

II. Employment

The applicant has estimated the average construction crew size to be between 30-35 persons. This figure approximates manpower levels projected by the Montana Power Company in its other transmission line applications. Thirty-five construction jobs are equivalent to about .1% (one-tenth of one percent) of the labor force in the four-county area.[7] With approximately 27,000 Montanans unemployed,[8] the Clyde Park-Dillon transmission facilities could mean jobs for .1% (one-tenth of one percent) of those out of work, provided they hold the requisite skills or union card. It is estimated that there will not be any long-term permanent employment directly attributable to the proposed facility. Maintenance and service personnel are hired to meet a general need, not simply to manage a particular transmission line. Therefore, the proposed facilities mean little in terms of employment.

III. Income

The proposed facilities will generate income to two basic classes of recipients. The first class is the utility, which will receive income because the lines will accommodate increased electrical deliveries and sales. The lines are a long-term investment, providing the applicant an opportunity to increase revenue. Specifically, just how much the proposed facilities will be worth to the company is difficult to calculate. It depends on the amount of electricity sold, sale price, and operating costs. These are variable commodities and will change significantly over time. Nevertheless, it is probably safe to assume that the applicant will amortize its investment and earn some profit.

The second class of income recipients are those receiving payment for goods and services used in line construction and maintenance. This includes wage and salary income and money received from the sale of commodities such as conductors, right-of-way, and tower structures. The applicant paid filing fees to the Department of Natural Resources based on an estimated cost of $29,000-$30,000 per mile of 161-kV line, and $18,000 per mile of 69-kV line. A detailed itemized breakdown of costs was not received.

The applicant has estimated labor costs at $10,500-$20,000 per mile.[9] The Clyde Park-Dillon 161-kV facilities total approximately 163 miles. The proposed 69-kV segment from Emigrant to Gardiner is about 25 miles. According to the applicant's figures, labor costs would run from $2,310,000-$4,400,000. These estimates appear too high. Subsequent material filed by the applicant suggests that actual wage payments to construction workers will be equal to about one-half or one-fourth of the labor costs cited above (see Table 6-11).

Taking crew site and hourly wage rates into consideration, the weighted average annual earnings for construction workers is $15,524. Assuming an average crew size of 35 workers for the full 20-month construction period, wage payments would approximate $905,567. IBEW contracts include a provision for travel pay ranging from $6.00-$16.50 per day, depending upon the distance to the job. Assuming a $12,000 daily allowance for travel, with a weighted average of 243 work days per man, travel pay would add approximately $3,000 to the earnings of each worker covered by the IBEW contract. Total travel pay is estimated at $105,000.

Other types of labor costs for which no definitive breakdown is currently available will raise the total wage payments. As a matter of simplicity, those costs are assumed to be 25% of the estimated wage-travel bill, or approximately $252,642. Total wage payments are thus estimated at $1,263,209. Actual wages paid will depend on a number of factors, including actual crew size, negotiated changes in wage rates (the current agreement expires on May 31, 1976), amount of overtime work, and so forth. The $1,263,204 figure appears to be a reasonable estimate based on the limited information available.

While the proposed projects may provide a net increase in income to a few selected individuals and firms, it will not have a noticeable effect on local communities. The estimated total wage payments to construction workers would amount to approximately .7% (seven-tenths of one percent) of total income in the four-county study area.[10] Moreover, these income payments are spread out over a 20-month construction period and dispersed by the geography of worker residences. In the long run, operation and maintenance of the facilities will result in continual income generation, but its scale will not constitute a significant impact.

TABLE 6-11

CONSTRUCTION SCHEDULING, CREW SIZE, AND WAGE RATES

Construction Activity	Crew Size	Time Rate	Hourly Wage Rate
Material Dispersion	2 Operators	1.2 mi/day	$ 7.83
	2 Groundmen		$ 6.46
Hole Digging	1 Operator	0.8 mi/day	$ 7.83
	1 Groundman		$ 6.46
Frame Structures	1 Foreman	0.8 mi/day	$ 8.99
	1 Lineman		$ 8.54
	1 Operator		$ 7.83
	2 Groundmen		$ 6.46
Set Structures	1 Foreman	0.9 mi/day	$ 8.99
	3 Operators		$ 7.83
	2 Linemen		$ 8.54
	4 Groundmen		$ 6.46
String Wire	1 Foreman	0.7 mi/day	$ 8.99
	4 Operators		$ 7.83
	4 Linemen		$ 8.54
	7 Groundmen		$ 6.46

SOURCES: Montana Power Company, Written Communication. September 16, 1975

Montana Agreement, Power Utility and Transmission Construction; between Western Line Constructors Chapter, Inc., NECA, Inc. and Local Unions' 44 and 532 IBEW (1975)

IV. Taxation

The most significant fiscal impact of the proposed facilities appears to be in its long-term contribution to county tax bases. Table 6-12 illustrates the 1974 assessed valuation of utility property in the four study area counties. The figures include assessments for railroads, telephones, water companies, pipelines, and other utilities, as well as assessments of electric utilities. Utility property accounts for approximately 10% of the 1974 assessed valuation in each county. The differentiation between locally assessed property of public utilities *vis-a-vis* public utility allocations by the State Department is crucial to projecting the potential tax contribution of a transmission line.

Transmission lines are *not* assessed in the same manner as substations, generating plant office buildings, or vehicles which are assessed locally, the same way an individual dwelling or business is evaluated. The State Department of Revenue assesses power lines as part of an overall assessment of the utility company. An assessed value per mile of transmission line is then allocated back to the individual counties for the levying of property taxes.

Determining the value of a transmission line is a complex process. At the risk of oversimplification, it is described here. First, the Department of Revenue prepares a unit assessment of the entire company (i.e., Montana Power Company). This assessment is made using three different approaches synthesized into a composite unit value. The approaches to unit assessment include:

(1) *Income Approach*. The value of the firm based upon net revenue capitalized after taxes and depreciation.

(2) *Property Approach*. The value of the firm based upon the original cost of all plant.

(3) *Stock-Debt Approach*. The value of the firm based upon the market value of stock and debt.

The second step in the assessment process consists of subtracting the value of all locally assessed property from the total unit assessment. As previously mentioned, locally assessed property includes such things as substations, generating plants, automobiles, office buildings, repair shops, and equipment, etc. Step three, the net value of the company (i.e., unit value minus locally assessed property), is divided up and allocated to the individual counties in which the utility operates, based upon the number of miles of power line. Table 6-13 shows the 1973 and 1974 allocations to the four counties of the study area from Montana Power Company property.

In determining transmission line allocations, the Department of Revenue attempts to base its determinations upon the contribution of the power lines to the worth of the system. Thus, as kV ratings increase, so do allocations (as a general rule). Also, since transmission line allocations are contingent upon the value of the company, it is possible for allocated values to vary significantly from year to year or from line to line even with kV rating held constant. Table 6-14 lists eight 161-kV lines in the Montana Power Company system and their respective 1975 allocated values per mile. As the table illustrates, there is no consistent value per mile of transmission line.

TABLE 6-12

1974 ASSESSED VALUATION
DILLON-CLYDE PARK STUDY AREA

	Property Other Than Public Utilities	Local Property of Public Utilities	Public Utilities Allocated by the State Department of Revenue	Net Proceed Assessment	Total Valuation
Beaverhead County	$ 51,298,086	$ 1,328,686	$ 5,119,756	$ 1,506	$ 57,748,034
Madison County	$ 38,931,899	$ 1,597,224	$ 2,908,011	$ 2,248,141	$ 45,685,275
Gallatin County	$ 131,228,182	$ 4,580,536	$ 11,695,745	$ 182,738	$ 147,687,201
Park County	$ 47,815,528	$ 3,496,528	$ 5,729,361	$ 0	$ 57,041,417

SOURCE: Report of the State Department of Revenue, to the Governor and Members of the Forty-fourth Legislative Assemply of the State of Montana, for the period July 1, 1972 to June 30, 1974. Helena, Montana.

TABLE 6-13

ALLOCATIONS OF MONTANA POWER COMPANY PROPERTY TO COUNTIES 1973 - 1974

	Assessed Value 1973	Assessed Value 1974
Beaverhead	$ 1,280,746	$ 1,068,988
Madison	$ 1,076,849	$ 1,065,569
Gallatin	$ 3,726,149	$ 3,808,119
Park	$ 1,255,199	$ 1,142,099

SOURCE: Report of the State Department of Revenue, for the period July 1, 1972 to June 30, 1974. Helena, Montana.

TABLE 6-14

MONTANA POWER COMPANY 161-kV TRANSMISSION LINES 1975 ALLOCATED ASSESSED VALUES
(per mile)

Name of Line	Allocated Assessed Value (per mile)
Anaconda - Billings	$ 1,548
Anaconda - Butte	$ 1,943
Champion Tap at Bonner	$ 6,455
Clyde Park - Bozeman "A"	$ 2,832
Kerr - Anaconda "A"	$ 1,796
Rainbow - Havre	$ 2,078
Rattlesnake Swyd - Missoula #4 Sub	$ 5,114
Missoula #4 Sub - Hamilton Heights	$ 4,192

SOURCE: 1975 Montana Power Company Inter County Electric Transmission Line Data for the Montana Department of Revenue.

During the fall of 1974, supporters of the Colstrip generating and transmission projects consistently pointed to the tax revenues anticipated by the construction of twin 500-kV lines.[11] Those claims were spurious. Because of the allocation procedure, it is impossible to state the taxable value of any power line, be it a Colstrip-Hot Springs 500-kV or a Clyde Park-Dillon 161-kV line. To provide a range of possible taxable values for the proposed facilities, Table 6-15 has been prepared. The values contained therein should not be construed as anything more than conjecture. Three values are reported. One value is derived by estimating the 1975 mean (average) value of existing 161-kV lines in the Montana Power Company's system. A second value is derived using a median (middle) allocated value. The final set of numbers uses the highest per-mile allocated value for 161-kV lines.

Table 6-16 illustrates that a wide range of taxable values would be within the limits of reasonable conjecture. Obviously, those counties with the greatest amount of transmission line mileage would be the recipients of the greatest amount of new taxable valuation. Adjustment would also be made for the removal of approximately 35 miles of existing 50-kV line in Madison and Gallatin Counties. Those 50-kV lines had a 1975 allocated value near $400.00 per mile.

The proposed transmission lines will affect the tax bases of the counties crossed. Some addition to the tax base is certain, but the amount is unspecifiable at this time. The lines do not constitute any type of tax bonanza for any county. They constitute a small addition to the tax base which will be present for many years to come.

Local tax bases will also be affected by substations and other facilities with the proposed lines. This property is locally assessed. Table 6-16 contains the dollar cost of additions to substations, as well as the estimated addition to assessed and taxable valuations. Madison County will receive the largest addition to 1975 taxable valuation, of $106,400. Beaverhead County will add $9,600; Gallatin County will grow by $18,400; and Park County will climb $56,800.

V. Rates

Additions to operating plant are added to the rate base. The utility's rate of return is regulated, in part, according to the amount of capital invested in electric plant. The proposed facilities will add over 7.5 million dollars to the rate base. This addition will probably be made at the applicant's first formal request for rate readjustment after the projects are completed. Inflationary pressure and bringing the Colstrip units 1 and 2 on line make it likely that the company will seek further rate readjustment in 1977 or 1978. At that time, the transmission facilities under consideration will be likely additions to the company's rate base.

While it is known that the proposed power lines will be added to the company rate, it is impossible to predict whether rates will be affected. The company is entitled to a return on its investment, and the return must cover material and interest charges associated with the facilities, as well as operating expenses. Offhand, that would suggest an upward rate adjustment, but the new lines will also produce new revenues that may be sufficient to cover costs associated with the lines.

TABLE 6-15

ESTIMATED ADDITIONS TO COUNTY TAX VALUATIONS
161-kV DILLON-CLYDE PARK LINE
161-kV BOZEMAN "B" LINE
69-kV EMIGRANT-GARDINER LINE

		Assessed Valuation	Taxable Valuation[1]
Clyde Park-Dillon 161-kV line			
Beaverhead County (approx. 14 miles of line)[3]	mean value[2]	$ 43,456	$ 17,382
	median value	$ 29,092	$ 11,637
	high value	$ 90,370	$ 36,148
Madison County (approx. 95 miles)	mean value	$ 294,880	$ 117,952
	median value	$ 197,410	$ 78,964
	high value	$ 613,225	$ 245,290
Gallatin County (approx. 19 miles)	mean value	$ 58,976	$ 23,591
	median value	$ 39,482	$ 15,793
	high value	$ 122,645	$ 49,058
Park County (approx. 39 miles)	mean value	$ 121,056	$ 48,422
	median value	$ 81,042	$ 32,417
	high value	$ 251,745	$ 100,698
Bozeman "B" 161-kV Line			
Gallatin County (approx. 12 miles	mean value	$ 37,248	$ 14,899
	median value	$ 24,936	$ 9,974
	high value	$ 77,460	$ 30,984
Park County (approx. 15 miles)	mean value	$ 46,560	$ 18,624
	median value	$ 31,170	$ 12,468
	high value	$ 96,825	$ 38,730

TABLE 6-15
(continued)

		Assessed Valuation	Taxable Valuation[1]
Emigrant-Gardiner 69-kV Line			
Park County (approx. 25 miles)	mean value[4]	$ 34,400	$ 13,760
	median value	$ 16,000	$ 6,400
	high value	$ 170,450	$ 68,180

NOTE: On September 16, 1975, the applicant provided estimated transmission line mileages per county as follows: 161-kV line including Bozeman "B" line - Park, 57 miles; Gallatin, 32 miles; Madison, 91 miles; Beaverhead, 15 miles. These estimates slightly vary with those included in the Table #5 independently calculated by the Energy Planning Division. Since the differences are very small, and because the final corridor may alter both sets of calculations, the table presents one estimate only.

[1] Taxable valuation is equal to 40% of assessed valuation. Assessed value is equal to 40% of full value.

[2] For 161-kV Lines: mean value = $ 3,104 per mile
median value = $ 2,078 per mile
high value = $ 6,455 per mile

[3] Length of line segments taken from the applicant's preferred corridor.

[4] For 69-kV Lines: mean value = $ 1,376 per mile
median value = $ 640 per mile
high value = $ 6,818 per mile

TABLE 6-16

SUBSTATION ADDITIONS
ASSESSED AND TAXABLE VALUATION

County	Substation Location	Estimated Cost New	Assessed Valuation[1]	Taxable Valuation[2]
Park	Clyde Park-East Gallatin 161-kV Terminal	$ 110,000	$ 44,000	$ 8,800
	Clyde Park-Emigrant 161-kV Terminal	$ 120,000	$ 48,000	$ 9,600
	Emigrant Switchyard	$ 480,000	$ 192,000	$ 38,400
Gallatin	East Gallatin-Clyde Park 161-kV Terminal	$ 110,000	$ 44,000	$ 8,800
	East Gallatin-Ennis 161-kV Terminal	$ 120,000	$ 48,000	$ 9,600
Madison	Ennis Switchyard	$ 805,000	$ 332,000	$ 66,400
	Big Sky Switchyard (Mountain Village)	$ 505,000	$ 202,000	$ 40,400
Beaverhead	Dillon-Salmon 161-kV Terminal	$ 120,000	$ 48,000	$ 9,600

SOURCE: Montana Power Company, Written Communication, October 21, 1975.

[1] Assessed valuation is equal to 40% of the estimated cost new.

[2] Taxable valuation is equal to 20% of the assessed value. Substation machinery is class two property. See R.C.M. 84-301.

In seeking to make some type of hard determination with respect to "rate" impact, the Department sought assistance from the staff of the Public Service Commission's Utility Division. After extensive discussion, it was agreed that so many variables intervene in the rate-making process that a definitive statement was impossible.

VI. Conclusion

In conclusion, the preceding analysis has outlined the reasonable impacts of the proposed facilities from an economic perspective using relatively standard indicators. The fiscal impacts are minor and largely inconsequential.

Within impact statements, it is common to evaluate the impact of the proposed facilities upon government expenditures as well as revenues (i.e., taxes). Here, that is not done. As the preceding analysis has illustrated, economic impact is minor. Expenditure patterns, public or private, are not going to be significantly affected by the lines. Increased demands for services will be absorbed by the existing economic structure without difficulty.

6.3.3.4. Sociology

I. Introduction

The social impact of a transmission facility emerges from two sources--the physical and symbolic presence of the line. Social impacts caused by the physical presence of a line are mostly problems related to the construction and post-construction periods. Social impacts caused by a line's symbolic presence are defined mostly by attitudes of the residents of an area where a line is proposed. Both sources of impacts are discussed in greater detail in the following pages.

II. Physical Presence of the Line

Section 6.3.3.2., land use, has dealt with the most common impacts associated with the line's physical "being." There are, however, additional "physical presence" impacts which are broadly classified as social. They are primarily nuisance impacts, being limited in scope, and capable of being rectified through engineering design and conscientious supervision of construction and maintenance activities. Frequently listed impacts of this type include:

(1) Property damage to crops, agricultural land, fences, and gates by construction and maintenance crews straying off the right-of-way or access roads with private vehicles and construction equipment.

(2) Domestic animals escaping from enclosures because transmission line workmen left gates open or damaged fences. Loose livestock constitute a hazard to operators of motor vehicles, a potential property loss to their owners if

they are killed, injured, or lost, and a possible source of crop damage.

(3) Construction and maintenance activities not being followed with sufficient clean-up and restoration. Special reference is made to inadequate debris disposal and improper vegetative re-seeding.

(4) Tower structures taking cropland out of production. The problem is aggravated when more than one line occupies a right-of-way. If tower structures are staggered, as they often are because line spans vary in length, the movement of agricultural equipment can be made more difficult.

(5) Corona effects downgrade the quality of radio and television reception.

(6) Aesthetic impacts are created; for example, clearing of trees from a right-of-way in forested lands.

A standard fare in an impact statement of this sort is to include discussion of the proposed facility's impact upon social structure and services. In this case, such an endeavor would be superfluous. Social impacts are pre-eminently caused by construction activity (especially the influx of a construction population). For the proposed transmission lines, however, construction crews will be small and transient. The associated population change will be largely unnoticeable. For example, 35 construction jobs implies a population impact of 80 persons assuming all workers are in-migrants and that 50% of the workers are married with 1.5 children per married couple. The probable population change will not be so great, as local residents can be expected to fill some construction jobs, particularly those associated with road construction and right-of-way preparation. Moreover, the construction-related population will be geographically separated; the applicant's construction schedule shows plans to work on line segments in the Paradise Valley of Park County at the same period that work is planned from Dillon to Big Sky. In addition, service centers such as Bozeman, Livingston, and Dillon can be expected to draw migrant workers. These areas have the capability of absorbing a transient construction work force of 35 persons and its associated population.

Likewise, the impacts to existing social structures are expected to be of little consequence. Line construction workers and their families will be like "tourists" in an area where tourism is an integral part of the local economic and social context. Also, attempting to measure the social impact of a transmission line across hundreds of miles of landscape is fraught with methodological difficulty. Pragmatic constraints of budget and time do not allow determination of existing social structures. Community studies take years, not days (for example, see Warner et al. 1963, Vidich and Bensman 1968, Lantz 1958). Furthermore, no studies have indicated any adverse social structural impacts associated with transmission lines of the design, scale, and size approximated by the proposed 161- and 69-kV facilities.

III. Symbolic Presence of the Line

Social impact due to symbolic presence of a line is evident in organized reaction to the "concept" of the transmission line, be it support or opposition. Reaction is an extremely variable commodity. Some lines go unnoticed (e.g., Anaconda Arbiter 230-kV line). Others engender a great deal of consternation (e.g., Missoula-Hamilton 161-kV line). The impact process includes the marshalling of forces to affect a decision or determine a policy. While the immediate effect of impact-related activities is to ensure or enjoin the line's construction, the long-run policy implications and latent consequences of the facility constitute the major social impact.

In the months which have intervened between the filing of the Clyde Park-Dillon application and the present, departmental personnel have been advised of the "environmental/policy" concerns of various individuals, groups, and organizations with respect to the application. In the paragraphs that follow, a discussion of these concerns is presented. This discussion should not be construed as the results of a systematic process of studying and evaluting public opinion. Issues discussed are those which have been brought to attention, and by no means constitute an exhaustive or hierarchal list of issues. For analytical purposes, the major environmental/policy concerns are categorized as supportive of, or opposed to, the proposed facilities.

III.A. Concerns Supportive of the Transmission Project

III.A.1. Power Equals Prosperity

This position has been associated with virtually every application processed by the Energy Planning Division. In its purest form, it is the recognition that a healthy economy requires sufficient resources, including electrical energy. The evolution of this point of view has modified the argument to "electric power equals prosperity." It is a frequently-used equation when justification of industrial development appears necessary. For example:

> Producing electricity will create hundreds of new jobs and millions of dollars in tax revenues for Montana and the 500-kV lines will be one more vital link in a strong economy for the treasure state (Montana Power Company, 1974).
>
> In the years ahead, more electricity will mean more food for Montana - more production to help our farmers prosper (Montana Power Company, 1974a).

With specific reference to the Clyde Park-Dillon application, the transmission facility has been linked to economic development. This is seen in continued growth at Big Sky, and a "utility" stimulus to subdivision sales in the Gallatin Canyon and near Ennis.

Economic development is usually defined as beneficial, giving a supportive stimulus to any project holding out the faintest hope for increased economic activity. Actually, economic development is more complex than its slogans would suggest. The link between energy availability and economic development is not consistently supported in fact (see Smith et al. 1971, Altouney 1963, Eckstein 1958, Freeman 1966). Butte and Anaconda provide a "closer to home" example. The largest substation in the applicant's system is located at Mill Creek, just east of Anaconda. The Butte-Anaconda area has the largest electric load in the Montana Power Company service area. Both communities are depressed. Population and employment continue to shrink despite increasing electrical loads.

Nevertheless, many persons see all forms of energy development as inextricably tied with economic prosperity. Power lines are to serve a load. Their ability to create one is questionable.

III.A.2. Need at Big Sky

Big Sky is an "all-electric" resort and real estate complex. Its operation depends upon the availability of electricity in significant quantities. The "all-electric" concept has implications for planned future growth; growth and remaining "all-electric" will necessitate additional electrical energy. The existing transmission system cannot accommodate much more growth. During the 1974-1975 winter season, Big Sky officials reported 4 power outages of 12 or more hours (Raaum and Blakely 1975). The "all-electric" nature of the complex intensifies the need for reliable services. It has been stated that when Big Sky loses power, it "loses business, reputation, and, maybe, lives" (Raaum 1975).

The power requirements of Big Sky do not necessarily point to the transmission facility as proposed by the applicants. Alternatives exist. Big Sky officials have been steadfast in claiming a need for additional power, but have not ruled out alternatives to the proposed facility, as indicated in the dialogue below:

Question:	You cite a need for additional power. Do you care how it gets here?
Answer:	Only so it doesn't affect our operations here. We don't want it (transmission line) across the ski lifts on the south side of Lone Mountain. That is an area of major scenic values. Up here (points to a map indicating a substation on the north side of the complex) is probably the best place . . . The least acceptable alternative is permanent on-site generation (Raaum 1975).

For Big Sky, the need for electricity is central to total development and effective operation. The proposed facility is symbolic of a secure electric future. The particular design and route of the line is generally of less consequence than its electrical presence.

Subsequent to a meeting with Big Sky officials on August 13, 1975, the Department received written communications from Big Sky which advocated a transmission route from the west (i.e., from the Ennis area to Big Sky). The Energy Planning Division asked Big Sky to explain its new position. The answer given is as follows:

> The reason we mentioned a route from the west is that: (1) we have pretty much been told that any larger line up the Gallatin Canyon is totally out of the question, and (2) the only alternatives presented to date are from the west. For our purposes, power input at both the Meadow and Mountain Village areas is necessary to provide our customers with the best accommodations possible. This includes electrical energy necessary for their stay and use of all facilities at Big Sky. Electric power is now delivered through the Gallatin Canyon to Meadow Village. An electric power supply to Mountain Village is now necessary and it simply appears logical that supply come from the west. This supply would afford an alternate source to our Big Sky area, which most often is not subject to the same weather and natural problems as encountered in the Gallatin Canyon. Last week, for example, we were subject to two (2) outages, totaling 16 hours within a 24-hour period. From our operating experience last year and thus far in 1975, it has become apparent that an alternate source of power along a route different than the present line location is absolutely necessary (Raaum 1975a).

III.B. Concerns Opposed to the Transmission Project

III.B.1. The Wedge Hypothesis

This hypothesis actually consists of many concepts, each of which sees the proposed facility as a wedge being driven into the environment and acting as a lever of change in the future. This perception is fundamentally in opposition to the proposed transmission project. More specifically, it is in opposition to building the line from Ennis to Big Sky, crossing the roadless and undeveloped Madison Range. The most frequently cited arguments are:

(1) The power line will separate the proposed Taylor-Hilgard wilderness from the Spanish Peaks primitive area. The line is seen as a developmental wedge which may ultimately prevent wilderness designation. The Wilderness Act of 1964 states that wilderness areas must be managed to maintain their primitive character (PL 88-557, 1964). By definition, transmission lines are excluded.

(2) The presence of a transmission facility will open the door to other types of man-made intrusions, especially an all-weather road from Ennis to Big Sky. This concern reflects the knowledge that a road from Big Sky to Ennis

> has been sought for some time. Madison County residents have been the road's key sponsors, apparently seeing an economic stimulus in a link with Big Sky.

The wedge hypothesis is being illustrated by the Alaska pipeline. There, lobbyists are seeking to open the pipeline haulage road to public travel. An editorial from *The Independent Record* (September 10, 1975) summarizes the situation:

> . . . get your foot in the door, under any pretext, and then justify entering the house because the door is already open.
>
> The pipeline was (supposedly) built for one reason, to supply the lower U.S. with badly needed oil. The energy crunch was the justification for crossing the interior of Alaska. But millions of dollars were spent in the design and construction of the pipeline to minimize its effects on the environment and to ensure it would disrupt the arctic wildlife as little as possible.
>
> The haulage road was to be used only to construct and maintain the pipeline.

The transmission line is seen in analogous terms. Once built, whatever justification was used to keep the developmental lid on the area is of little consequence. The transmission line does not necessarily cause roads or subdivisions, but after one development is opened, it is increasingly difficult to halt the second.

The wedge hypothesis has considerable similarity to the proposition that "power equals prosperity." Both deal with the future "developmental" consequences of the line rather than the line itself. Both suffer from overgeneralizing their cases. Given the existing social and economic resources of the study area, the wedge hypothesis will probably be more accurate.

III.B.2. Big Sky's Load - Big Sky's Cost

This is a relatively straightforward *appearing* issue. Since the line is pre-eminently designed to serve a load at Big Sky, service should only be provided if Big Sky is willing to bear a proportionate share of the cost. Transmission lines built to serve a specific load should not be put into the general rate base requiring all utility customers to pay the cost. There is no socially justifiable reason that electricity to a resort used by a limited number of persons should be subsidized by all Montana Power customers in their utility bills. Moreover, if Big Sky wants the power, it should be willing to pay the non-monetary costs of the line, such as having it located on its own property rather than on public land.

This issue is straightforward in appearance only. Questions of who is subsidizing who end up a "can of worms." For example, it must also be asked who is subsidizing industry, residents of rural areas, and others.

III.B.3. Despoilation of the Environment

Putting aside issues such as blocking the formation of wilderness areas and opening the Big Sky and adjacent areas to development, there is the concern that the transmission line will lead to environmental damage. Damage is broadly defined. It includes aesthetic scars, soil erosion, vegetative reduction, and reduction of wildlife carrying capacities. Each of these topics is dealt with more specifically in other sections of this impact statement.

IV. Conclusion

In the preceding pages, a brief outline of issues related to the Clyde Park-Dillon transmission project has been presented. Criticism has been made where appropriate. The issues mentioned are not exhaustive or mutually exclusive. They pertain to the symbolic presence of the transmission lines--what the lines symbolize for the future. A transmission line, especially in the Madison Range, is more than a conduit of electricity. It has long-term implications for land use policy, including economic development and wilderness classification.

6.3.3.5. Aesthetics

I. Introduction

In describing the aesthetic presence of a transmission facility, an attempt has been made to link basic principals of landscape architecture with social science research regarding the nature of perception. The arguments presented here are, in part, theoretical. While scientists have sought to empirically measure and evaluate aesthetics, it would be premature to suggest that those endeavors have been successful. Nevertheless, in preparing this analysis, actual data and theoretical propositions were used whenever possible. Three aesthetic models are described in this section: visual frequency, visual character, and expectation. Preparation of the visual frequency model relied heavily upon traffic counts. The visual character model used topographical and vegetative information. Theory, rather than hard fact, is most apparent in the expectation model. Three maps were prepared to illustrate the delineated aesthetic elements: visual analysis-visual character, visual analysis-expectation, and visual analysis-frequency. They are included in this section.

II. Visual Character Model

The visual character perspective describes the general image of a given landscape as created by either the land use patterns or physical objects/edifices of that landscape (see the map entitled "Visual Analysis-Visual Character"). The objective of this approach is to summarize the extent of man-made alteration of a landscape from its natural state. The mapped categories (with examples) depicting the degree of alteration are:

1. Maximum alteration in three dimensions (a city)
2. Altered landscape with man-made visual dominance (agricultural land use pattern)
3. Altered landscape with natural dominance (forest landscape with some logging scars)
4. Little, if any, alteration (a wilderness area)
5. Mixed levels of alteration (residential and commercial establishments, farm land, timber, etc., mixed together in a continuous area)

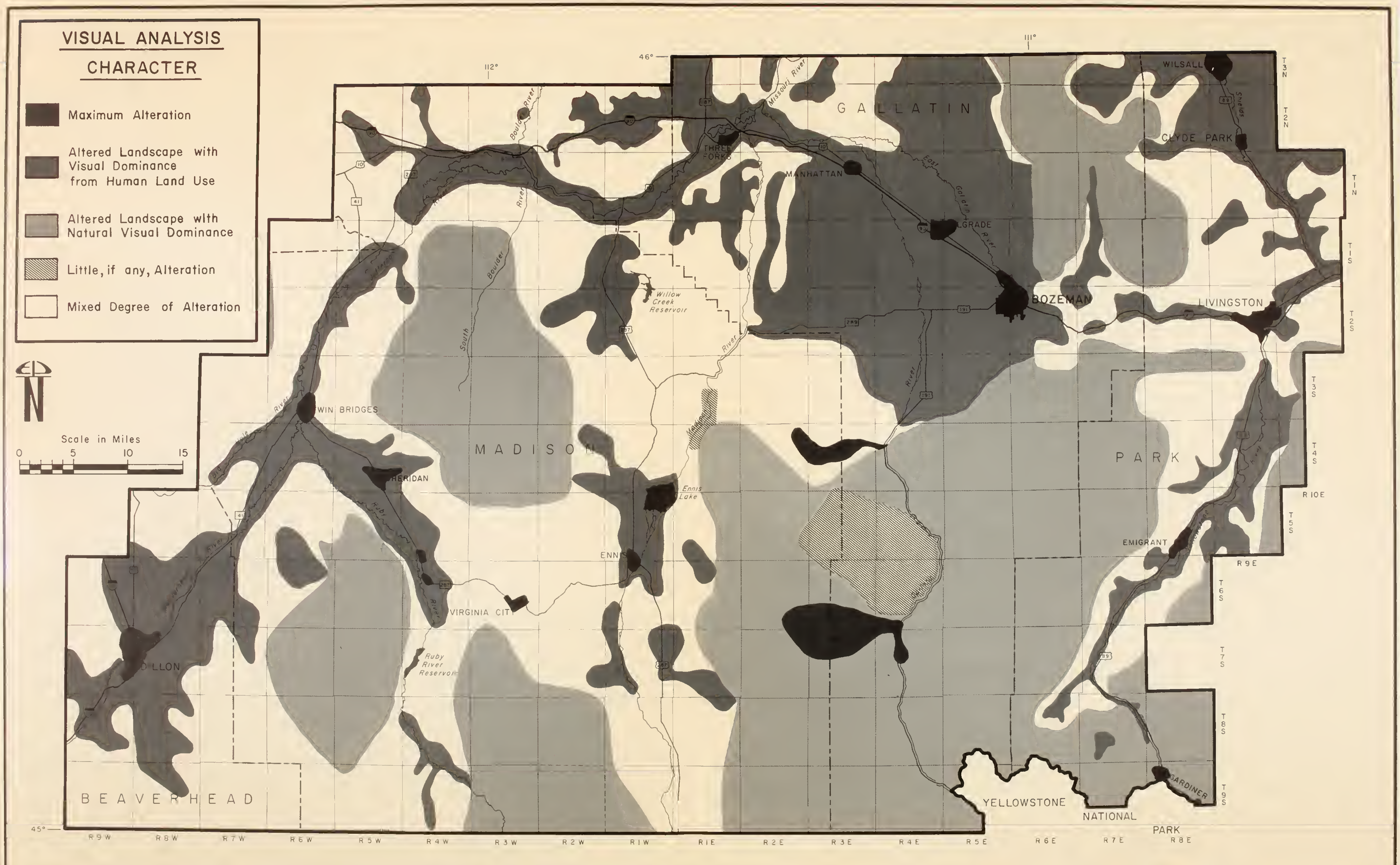
The visual "character" perspective "verbalizes" a landscape's visual image that is created by its constituent elements of man-made ingredients. The categories account for the introduction of the physical presence of the towers and conductors and the projected homogeneity of the resultant landscape based on the established image of the landscape on which the lines are located.

Not only is the physical presence of the line important in a visual impact assessment, but also the nature or image of the landscape accommodating the lines. This idea is expressed the following quote:

> Communicative actions are conceived of as events that occur in a certain context. The perception and evaluation of signals, both spatial and temporal, cannot be separated from the perception and evaluation of the situation in which they occur (Beck 1970, p. 134).

Introducing new land uses or edifices into a landscape immediately establishes a comparison between the new ingredient and the old image. If the two are of similar character, they would be in harmony; if not of similar character, there would be disruption of the existing landscape image and the new ingredient would be disharmony. It is the element of disharmony that would cause a more severe visual impact than if the introduced ingredient were in harmony with the existing landscape image. A visual impact is not necessarily a negative human response, but demonstrates a mental reaction to a situation of sharp contrasts, such as a hot dog stand on a lake front in a wilderness area, which would individually be interpreted as either a form of beauty or a degree of degradation, depending upon the individual's "experience, education and purpose" (Lang 1974, pp. 99-100).

The categories ranging from maximum, man-made alteration to no alteration correspond to a range from compatible to incompatible when the landscape is evaluated as a visual context for the presence of the line. For example, a



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161-kV line that is constructed in an urban, industrial complex (maximum man-made alteration) would elicit minimal reaction from a visual "character" perspective, and the landscape would be evaluated as compatible by the method herein described. The category "mixed level of alteration" is problematic. No clear pattern of dominance is established, owing to a diverse mixture of natural and man-made elements. In an area of this type, placement of a transmission line can be both harmonious and out-of-place. Much depends upon the character of small, localized visual settings which are the components of the larger area. Predicting and preventing visual impact in these locations must rest with center-line determination.

III. Expectation Model

The second analysis to predict the visual impact of the transmission lines has been based on the concept of expectation. This approach premises that there are mental associations between geographic locations and landscape images and what an individual expects to visually find in those areas, even if he has never been to a particular area before. The concept behind the expectation model is documented:

> A great amount of what is said to be perceived is in fact inferred (Bartlett 1956, p. 96).

The origin of an individual's expectation of how a landscape should look has many sources within the realm of personal experience, education and purpose. Expectations are built over time through literary sources, advertising, and previous associations with similar landscapes. For example, a "park" is defined in the dictionary as a "tract of ground kept in its natural state as for game, walking, riding, or the like" (Webster 1951, p. 611). The description articulates a popular image of a park and the expected association with trees, meadow-like spaces and assumed public access. If a piece of land is described as a national park, the image of a natural setting would be expected by most persons even if they had not previously visited the site.

Advertising is a primary source for creating an image of a place (e.g., "Virginia City," "national forest," "Yellowstone Treasure Country"). The Travel Promotion Unit of the Montana Department of Highways helps build an image of the study area in its publication, "Montana, Last of the Big Time Splendors," which facilitates the development of a mental image, and, therefore, an expectation of a place, area, etc. National forest land, which covers about 40% of the study area, is described in the following manner:

> The 10 national forests in Montana have become America's playground with 16,635,000 acres of public lands for outdoor recreation. Hunt, fish, camp, picnic, hike, snowshoe, swim, boat, ski, photograph wildlife, enjoy flowers and scenic vistas, climb granite peaks, take scenic drives, ride horseback, study nature or just enjoy the quietness of back country in Montana's National Forests (Montana Department of Highways 1974, p. 28).

An image has been created by words and pictures for not only national forests, but also for state parks and monuments, fishing streams, historic sites, backpacking, dude ranching, float trips, campgrounds, fishing access sites, and other points of interest.

Natural resources and environments have meaning because of their cultural definitions. This is a relatively new perspective, and is considered in the passage below:

> The view of resources as physically defined entities has been effectively critized, and in its place a view of resources as objects culturally perceived as useful has been advanced (Lucas 1970, p. 297).

Once the image of a landscape has been assigned a linguistic term, such as a park, or to a geographic location, such as the mountains, expectations are projected about the general ingredients within the imagined landscape. If the unexpected is encountered, one can expect a human response, which would be considered an impact.

A second ramification of the expectation theory develops from common attitudes about "public" spaces and "private" spaces. Attitudes toward landscapes reflect conceptions of human activity zones. Use of "public" space necessitates acknowledgement of an expanded network of land use criteria dictating accommodation of public facilities, whereas the use of "private" space focuses strictly on individual or family determinants for what exists in that space. A person would expect the presence of transmission lines in an urban area, but he would not expect a pole or support structure to be constructed on his property. The first attitude acknowledges a public need, while the second reflects our national concept of property and individual freedom. If one's private realm of influence is to be disrupted by public need, the question of individual sacrifice for the common good can be difficult to rationalize, and often is impractical to expect. The separation of private space from public space builds a contradiction into the expectation model. Power lines may be expected in man-made environments such as cities. But individual citizens do not expect the facility to be put on their property. In the first case, the visual association is one of harmony. In the latter case, visual perception is tempered by concepts of private property.

The expectation perspective on visual impact analysis is based on an individual's expectation of not seeing a transmission line in certain landscapes or entities of pre-calculated character (see map entitled "Visual Analysis--Expectation"). A range from high to low expectation of not encountering a transmission line is adapted to the study area from the viewpoint of an individual previously unfamiliar with specific locations or entities.

There are five categories mapped for the expectation model. The category ranked as high (not to see a transmission line) contains wilderness and primitive areas, historical sites, scenic rivers, and so forth. For this category, an area's definition is central. For example, wilderness areas are defined by law as having a character which precludes power lines. Historical sites draw upon the imagery of the past. Custer did not fight the Battle of the Little Big Horn beneath a power line. Man-made facilities of this type disrupt the historic imagery of a location. Likewise, other places that incorporate, as part of their social definition, concepts such as pristine, unspoiled, and uninhabited are linked to a high expectation not to see a transmission line.

A second category, classified as moderately high, refers to areas such as national forests and blue ribbon streams. The classification reflects a recognition that man uses and intrudes upon these entities. The expectation not to see a transmission line is greater, for example, than it would be for a wilderness area. But man-made artifacts are part of the landscape, and a power line would not necessarily be out-of-place.

The expectation not to see a transmission line decreases as man's influence becomes more evident in the landscape. The moderately low category incorporates small communities, scattered built-up areas, and other linear elements such as railroads, highways, and other power lines. The landscape is marked by man's influence, yet the type and scale is subdued. "Rustic," "pastoral," and "country" are words used to describe these settings. Power lines are not out-of-place, depending upon their size and design.

Urban areas and industrial sites are places where transmission lines are commonly located and strongly associated with the utilization ends of the facility. Thus, there is a low expectation not to see a transmission line.

Certain landscapes have a diverse, undifferentiated character. Dominant elements are difficult to distinguish. Moreover, the definitional character of the area is not concise. Lands falling in the "undifferentiated" class are largely private holdings with a multiplicity of uses. The degree to which a transmission facility would or would not be expected is related to the land's use and the corresponding definition of the landscape. It is difficult to delineate the expectation level for small tracts of ground in a heterogeneous setting. Center-line evaluation is necessary.

The discussion of the mapped categories draws upon an initial assumption that power lines have a direct association with industrial, man-made objects, as opposed to natural landscapes. A second assumption draws upon the assumed cause-and-effect relationship that exists between elements of the landscape. For example, there is a closer association between power lines and hydroelectric plant than there is between power lines and a mountain lake. Essentially, this assumption involves the concept of elements in harmony or disharmony in which an example in either case would be categorized as an impact. It is also possible that these impacts can be interpreted as exquisite beauty or pronounced ugliness, depending upon one's cultural perspective.

In this analysis, if the supposed purpose of the power lines were visually dominant on a landscape, then the effect of the presence of the lines would be considered less severe than if the lines were visually isolated from the cause. The weakness of this projection is that the analysis is valid for only this point in time or this state of public consensus. Public tastes change, as is demonstrated in automobile or architectural styles, so that any visual impact analysis applies only to current values and concepts of harmony and disharmony.

The "expectation" analysis is an evaluation of the study area to define areas of pronounced visual sensitivity because of preconceived images of what those areas should be. It is valid for the assumptions it makes and the cultural values it represents, which limits its longevity to the life of those values. Finally, the concept of expectation holds out its greatest promise for evaluating visual impacts in relatively circumscribed settings. Concise definitions of land types and uses are requisite. Large "undifferentiated" tracts of land are difficult to evaluate, and act as an impediment to the model's practical application.

IV. Visual Frequency Model

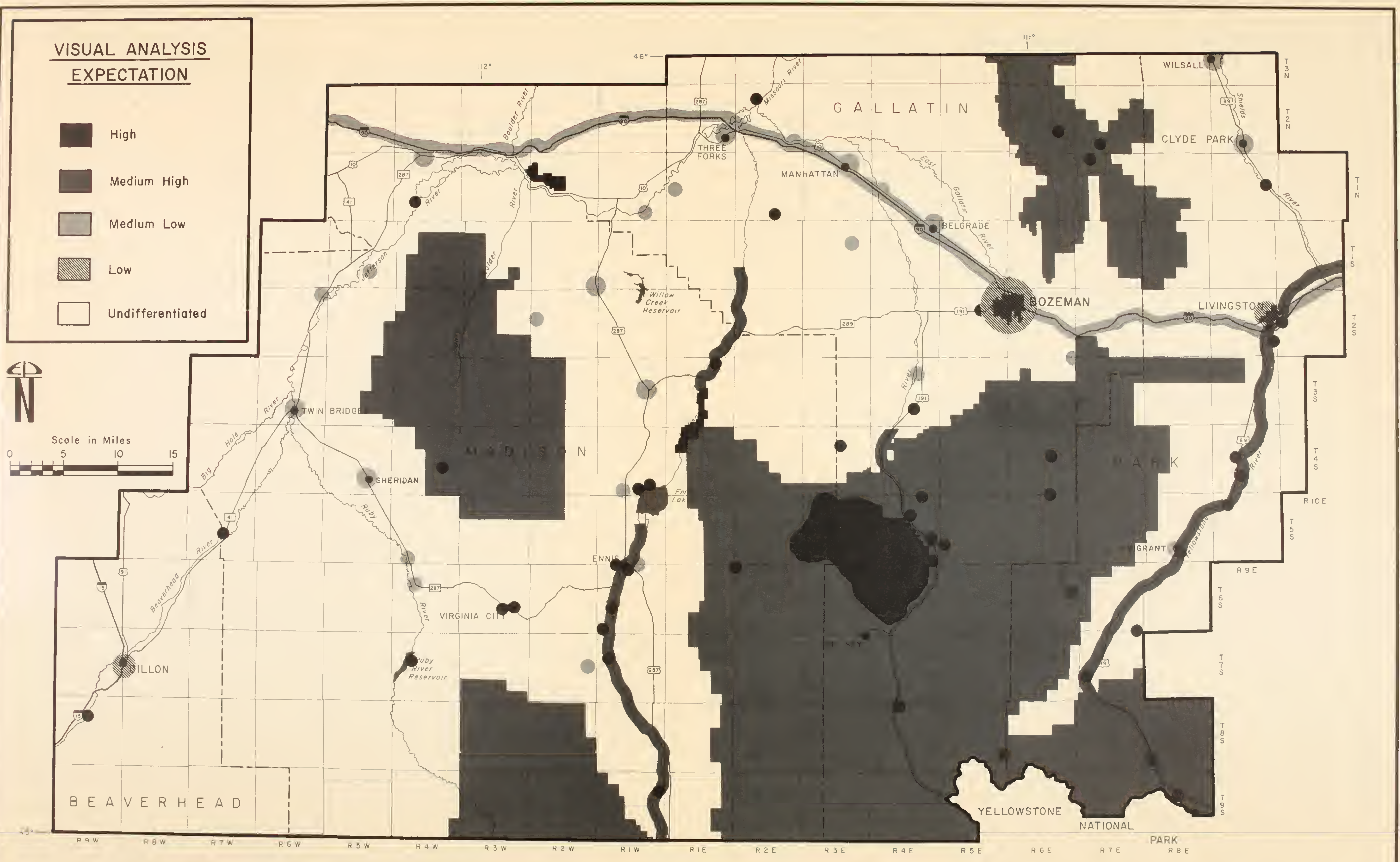
The third perspective used to describe visual impact is concerned with the frequency that the 161-kV transmission line would be seen determined by its geographic relation to high human activity areas and zones (see the map entitled "Visual Analysis - Frequency"). The mapped categories are drawn from highway vehicle counts. Using vehicle counts to measure potential visual impact has the flaw of equating the number of viewers with the severity of impact. Actually, many other variables are operative, such as observer focal distance and view angle. For example, the primary east-west four-lane freeway has more than 2,000 vehicles in daily use, but because of the 55-mile-per-hour speed limit, the cone of vision of the driver is reduced to about 64 degrees and a focal distance of 2,000 feet. Slower drivers have a wider cone of vision and a shorter focal distance so that they observe more of the surrounding landscape. A large number of drivers does not directly relate to a maximum number of observers. The smaller roads have fewer drivers, but more of these are driving for pleasure and are therefore more sensitive to their surroundings. Also, observation of the line does not specifically entail an impact, due to the problem that the visual context in which the line exists has to be defined before a human reaction can be formulated. Both the expectation and visual character models discuss this dimension.

Use of transportation routes to define visual frequency is done from the motorist's perspective rather than from that of the observer standing off to the side who sees the roadway as a linear pattern within the larger landscape. A transmission line would interfere with the view of the former and simultaneously be in "harmony" with the land use for the latter, so that each perspective is mutually exclusive. The motorist's point of view incorporates a focal distance with a one-half-mile limit to each side of the road; if the line were beyond the one-half-mile distance, it would be visually insignificant for a majority of viewers.

V. Potential Visual Impacts

An assessment of the potential visual impacts related to the presence of a 161-kV transmission line first necessitates the defining of the word "impact" within the parameters of the visual spectrum. The process of visual perception describes the interaction between the human brain and discrete elements of the physical environment:

> Perception of the environment requires man to interpret the physical and social components of his stimulus field (Beck 1970, p. 134).



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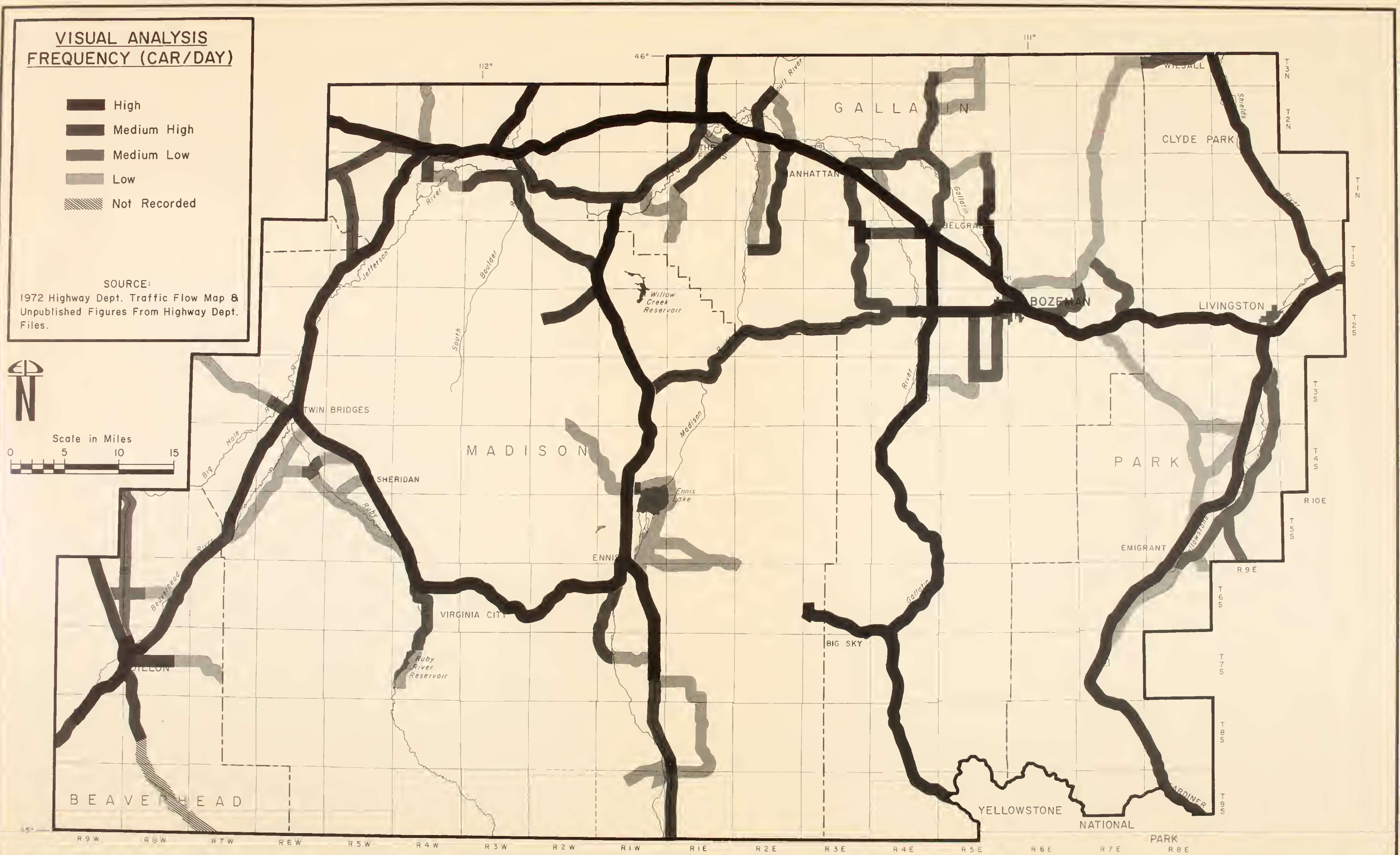

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The transactionalist theory of empirical perception best explains the role of interpretation in the visual process and the variability of individual responses, which are categorized as impacts:

> . . . what is perceived is a function of an individual's life history, motivations and values. Individuals, they say, create their own world: an assumptive one, of objects, people, and events out of transactions with the environment. . . . The main contribution of the transactionalist school has been to make us aware that different people attend to different things in the environment based on their own experience, education and purpose (Lang 1974, pp. 99-100).

The introduction of the interpretative mechanism into the visual process accounts for the varying reactions or impacts one can expect in the visual spectrum:

> Our aesthetic judgements are substantially modified by nonsensual data derived from social experience (Fitch 1970, p. 78).

The word "impact," when used in reference to human visual perceptions, describes a human response, which is an aesthetic judgement within the context of "experience, education and purpose." In order to determine a corridor alignment with least visual impact, a consensus of responses which acknowledges deviations because of the multiplicity of diverse cultural perspectives must be projected for a majority of persons.

In order to represent a projected popular consensus, the visual impact analysis has been addressed by three separate perspectives, which, when combined by computer overlays, delineate areas in which the visual impact can range from slight to maximum. A landscape's visual character, the public's expectations related to that landscape, and the frequency that the landscape is cumulatively viewed, anticipate the degree of human responses one can expect if the line is built.

VI. Conclusion

The combination of the visual character, expectation, and visual frequency perspectives delineates areas in which one can expect either a maximum, severe, moderate, or slight human reaction upon the visual senses. It is expected that a large number of persons observing a 161-kV line in a homogeneous landscape context would not generate a visual reaction or impact as great as that of a smaller number of people viewing a line in a disharmonious context. The methodological procedures used to evaluate visual impact allow for any one model to supersede the others. Specific contexts are important. For example, an area could be classified as having a high level of natural dominance within the visual character framework, an undifferentiated level of expectation, and low visual frequency, but still be a preferable choice for a utility corridor. Once a corridor is established, the utilization of known design principles can further mitigate visual impact of any transmission line, right-of-way clearing, and access road construction.

6.4. Corridor Selection

The selection of a two-mile-wide corridor, in which the transmission line will be built, is based upon a consideration of environmental, social, economic, and engineering concerns and the relationship of the line with a number of geographical patterns. A series of maps depicting environmental (natural and cultural) patterns are used to produce derivative maps on which a corridor can be established. The matrix (described in section 6.4.3.) is a device which combines the inventory data (environmental patterns) with the environmental, social, economic, and engineering concerns to establish the corridor. This section describes the corridor selection process.

6.4.1. Introduction

An infinite number of lines can be drawn between two points. Similarly, a transmission line may follow one of a large number of potential routes in connecting its terminal points. When certain conditions are placed on the line in the form of environmental, social, economic, and engineering concerns (e.g., least impact on terrestrial fauna) or constraints (e.g., not to pass through a wilderness area), a smaller number of potential routes exist. Ideally, there is one, and only one, route which is best suited in fulfilling the objectives and concerns of the line. If the sole objective of the line were to keep it as short as possible, a straight line between the terminals is the only route which would fulfill this objective. A real transmission line, though, involves many more concerns than its length. The cost of the line is an important consideration and the least expensive line is not necessarily the shortest. If all concerns and constraints could be identified and property considered, one route would be the "best route" for that line. The "best route" would involve a number of compromises. Although least cost is an important concern, the route that would achieve this objective would not necessarily be the one most compatible with other interests (i.e., the crossing of an airport or wilderness area). Therefore, the "best route" is the one which takes into account all the environmental, social, economic, and engineering concerns.

Although, ideally, there is only one "best route," it may, in practice, be difficult to distinguish between a small number of potential routes. This situation is the result of two factors: (1) not all persons evaluate the identified concerns in the same way, and (2) every fact potentially relevant to the siting of the line in the study area cannot be known. For instance, a hunter may favor a route that avoids the range of his favorite game animal, while a hiker may favor a route which interferes the least with his favorite hiking trails. A large number of conflicting interests thus enter into the selection of the "best route." Likewise, the costs and impacts of potential corridors can only be estimated from existing knowledge, and actual costs and impacts may vary somewhat from these estimates.

In the application for the Clyde Park-Dillon line, Montana Power Company designated its preferred route and several alternatives. It is possible that the "best route" is different from the applicant's preferred and alternative routes; therefore, the Energy Planning Division chose a corridor (a two-mile-wide strip of land) independently. The following sections of this report explain how this selection was done.

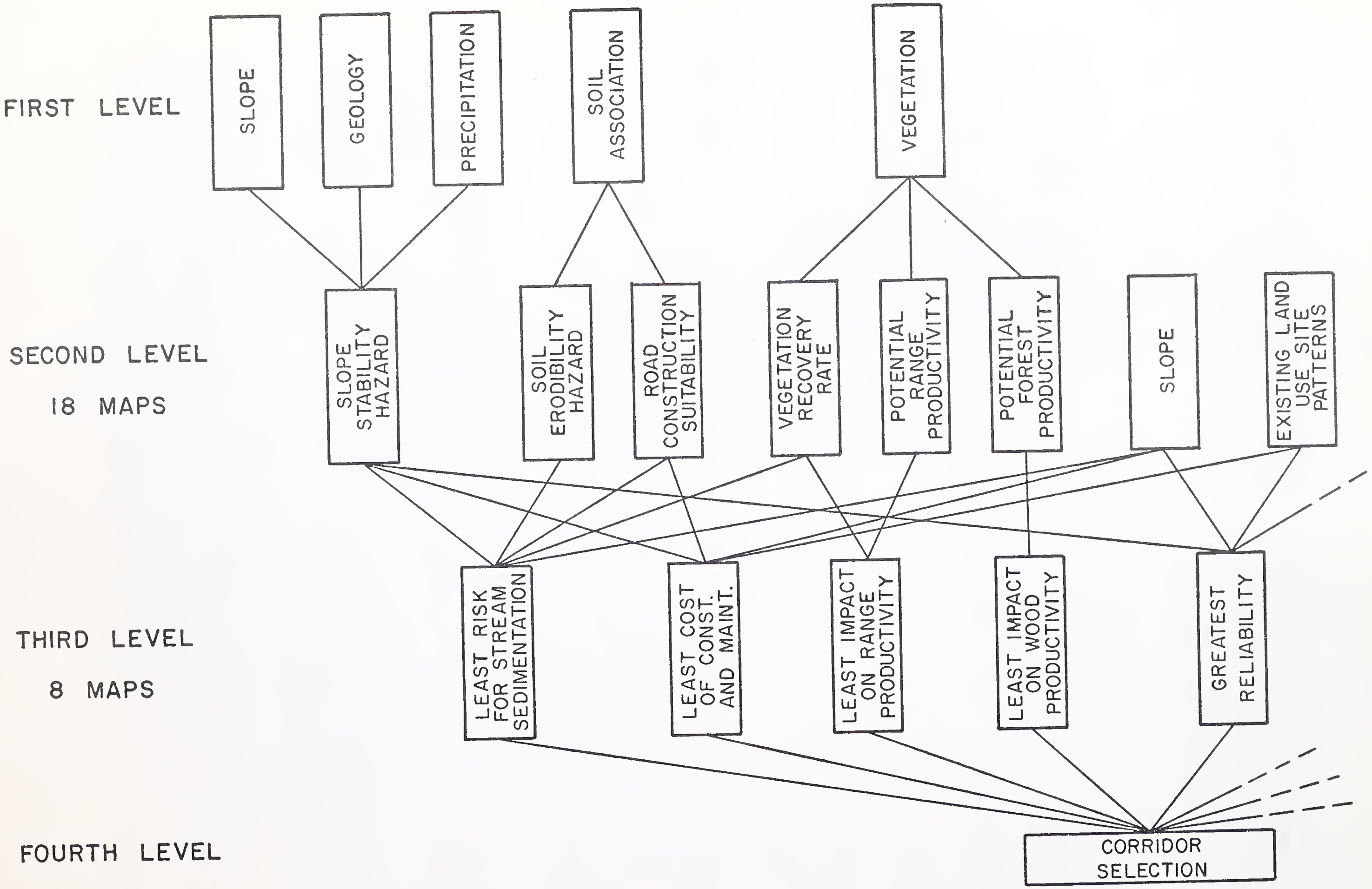
6.4.2. Maps

A transmission line is a man-made entity with geographic significance. The concerns it may (and does) raise and impacts it may create relate to things with spatial distribution which can be portrayed on maps. The process of corridor selection is just that--the selection of a two-mile-wide corridor through the study area connecting the terminal points of the proposed line. The assumption is made here, for the moment, that all impacts are mitigated by proper placement of the line and not by changing the design and construction practices. (This assumption is, of course, a temporary one to be used only in the corridor selection; a later section will concern itself with other mitigating measures.) A map can then be generated which takes into account environmental, social, and engineering concerns and which delineates areas of varying suitability for the proposed transmission line. Upon this map the corridor is selected. However, creating this kind of map requires the incorporation of many basic maps in a multi-step process.

The inventory of the natural and certain social elements of the study area manifests itself in a number of maps. These maps show such diverse parameters as the slope of all points in the area, average annual precipitation, the winter ranges of elk herds, and the location of airports, fishing access sites, and agricultural land. Some of these maps are difficult to relate to transmission line corridor selection, so they are combined with other maps to produce one which is more useful. The combining process was done two or three times before the final map, upon which the corridor was selected, was formed. A hierarchy of maps, therefore, exists (Figure 6-21).

The slope stability hazard map is a good example of how the map hierarchy came into existence. Slope stability is dependent upon the geology, slope, precipitation, and many other factors, most of which cannot be mapped over large areas. Although no map existed showing slope stability, maps did exist which provide the geology, slope, and precipitation. By combining the three existing maps, each point in the study area falls into one of 210 combinations of seven geology units, six slope zones, and five precipitation zones. Each of the 210 combinations was assigned a stability category of 1 to 4 (quite stable to highly unstable). These data were processed by a computer which produced the slope stability hazard map.

Other maps, such as the soil erosion hazard map on the second level, were produced from single maps. The 170 (+) units on the soil association map were lumped into five categories based upon the soil erosion hazard, forming a new map directly comparing erosion hazards. A similar map was derived from the soil association map, which compares road construction suitability of the soils. The slope map appears on level two due to its relationship with certain level three maps. The third and fourth levels are generated in the same manner.


FIRST LEVEL
SECOND LEVEL
18 MAPS
THIRD LEVEL
8 MAPS
FOURTH LEVEL
1 MAP
SLOPE
GEOLOGY
PRECIPITATION
SOIL ASSOCIATION
VEGETATION
SLOPE STABILITY HAZARD
SOIL ERODIBILITY HAZARD
ROAD CONSTRUCTION SUITABILITY
VEGETATION RECOVERY RATE
POTENTIAL RANGE PRODUCTIVITY
POTENTIAL FOREST PRODUCTIVITY
SLOPE
EXISTING LAND USE SITE PATTERNS
LEAST RISK FOR STREAM SEDIMENTATION
LEAST COST OF CONST. AND MAINT.
LEAST IMPACT ON RANGE PRODUCTIVITY
LEAST IMPACT ON WOOD PRODUCTIVITY
GREATEST RELIABILITY
CORRIDOR SELECTION

HIERARCHY OF MAPS USED IN CORRIDOR SELECTION

Figure 6-21

Maps on different levels of the hierarchy have different functions. Certain first-level maps have no direct use in corridor selection, but are used to generate second-level maps used in the matrix (explained in section 6.4.3.). Third-level maps show areas of differing suitability for the proposed transmission line based only upon a single concern (e.g., least risk for stream sedimentation). The fourth-level map shows areas of differing suitability for the proposed transmission line based on consideration of all identified concerns. Discussion of specific maps and how they are combined and used follows in the next section.

6.4.3. Matrix

The matrix shown in Figure 6-22 is the device used to generate the third- and fourth-level maps (discussed in section 6.4.2.). It consists of three basic components: (1) second-level maps and their units, displayed along the horizontal axis, (2) identified environmental, social, and economic concerns, or models, which are displayed along the left edge of the matrix, and (3) the numerical ratings of each map unit in the appropriate models. The formation of second-level maps has already been discussed (section 6.4.2.). The models and rating system will be discussed below.

It would be impossible to select the best corridor for the proposed transmission line without a set of objectives in the form of environmental, social, economic, and engineering concerns. These concerns (also called models) are stated as objectives and are listed below:

The transmission line corridor which would result in:

1. the least risk for stream sedimentation
2. the least impact on range productivity
3. the least impact on wood productivity in forest land
4. the least impact on terrestrial fauna
5. the least cost of construction and maintenance
6. the greatest reliability of the line
7. the least impact on existing land use
8. the least visual impact

The "best corridor" will be the one which takes into account all eight of these concerns. Therefore, the "best corridor" will be a compromise because any one point in the study area may be quite suitable for one concern and quite unsuitable for another. Each of the eight models is represented by one third-level map which delineates areas of different suitability based entirely upon the criteria of that one concern.

Using the first model as an example, it can be seen that the information contained on five second-level maps was relevant in selecting the corridor. The other maps shown on the matrix contained information not relevant in locating the transmission line to minimize stream sedimentation.

The numerical rating system allows evaluation of the mapping units within a given model. Slope, for instance, is relevant to the degree of impact or constraint in three of the models. The numerical rating in the matrix provides the ability to discriminate among the six slope zones on the basis of their suitabilities in each model.

THE TRANSMISSION CORRIDOR WHICH WOULD RESULT IN:									
THE LEAST VISUAL IMPACT	THE LEAST IMPACT ON EXISTING LAND USE	THE GREATEST RELIABILITY OF THE LINE	THE LEAST COST OF CONSTRUCTION AND MAINTENANCE	THE LEAST IMPACT ON TERRESTRIAL FAUNA	THE LEAST IMPACT ON WOOD PRODUCTIVITY IN FOREST LAND	THE LEAST IMPACT ON RANGE PRODUCTIVITY	THE LEAST RISK FOR STREAM SEDIMENTATION		
		4	4				5	Highly Unstable	SLOPE STABILITY HAZARD MAP
		3	3				4	Moderately Unstable	
		2	2				3	Generally Stable	
		1	1				1	Quite Stable	
							5	Very High Erodibility	SOIL ERODIBILITY HAZARD
							4	High Erodibility	
							3	Moderate	
							2	Low	
							1	Negligible	
			5				5	Very Poor	ROAD CONSTRUCTION SUITABILITY HAZARD
			4				4	Poor	
			3				3	Fair	
			2				2	Good	
			1				1	Very Good	
						5	5	Very Slow	VEGETATION RECOVERY RATE
						4	4	Slow	
						3	3	Moderate	
						2	2	Rapid	
						1	1	Very Rapid	
						5		Very Low	POTENTIAL RANGE PRODUCTIVITY
						4		Low	
						3		Moderate	
						2		High	
						1		Very High	
		4	5				5	>60%	SLOPE
		3	4				5	45-60%	
		2	3				4	30-45%	
		2	2				3	10-30%	
		1	1				2	5-10%	
		1	1				1	0-5%	
		3						Fault Hazard Zone	FAULT HAZARD ZONE
				5				Severe	WILDLIFE IMPACT POTENTIAL
				4				Large	
				3				Moderate	
				2				Small	
				1				Slight	
					5			Very Low	POTENTIAL FOREST PRODUCTIVITY
					4			Low	
					3			Moderate	
					2			High	
					1			Very High	
	2	3	3					Urban Areas	EXISTING LAND USE SITE PATTERNS
	3	2	2					Small Communities	
	3	1	2					Scattered Built-Up	
	4		3					Irrigated Land	
	3		2					Dry Cropland	
	2		1					Wild Hayland	
	1		1					Grazing Land	
	1							Interstate HW	EXISTING LAND USE LINEAR PATTERNS TRANSPORTATION
	2							Paved Roads	
	2							Graveled	
	3							Unsurfaced	
	4							Primitive	
	4							Designated Trails	
	1							Railroads	
	5							Airports	
	5							Spanish Peaks Proposed Wilderness Area	SPECIALLY MANAGED AREAS
	5							Primitive Area	
	4							New Study Area (USFS)	
	4							Citizen Proposed S.A.	
	4							Non-Selected Roadless	
	3							Game Management Areas	
	3							State Rec. Waterways	
	4							State Park	RECREATION
	3							Campgrounds	
	2							Fishing Access Site	
	3							Picnic Area	
	2							Highway Rest Area	
	4							Golf Course	
	3							Fairground	
	3							Ski Area	
	2							Subdivisions	POTENTIAL LAND USE
	4							Archaeologic Sites	HISTORIC AND ARCHAEOLOGIC
	4							National Register Sites	
	3							State Historic Sites	
	3							Ghost Towns	
1								Maximum Alteration	VISUAL ANALYSIS VISUAL CHARACTER
1								Altered Landscape Human Dom.	
3								Altered Landscape Natural Dom.	
5								Little Alteration	
2								Mixed Degree of Alteration	
4								High	VISUAL ANALYSIS EXPECTION
3								Medium High	
1								Medium Low	
1								Low	
1								Undifferentiated	
3								High 2000+	VISUAL ANALYSIS FREQUENCY (CAR/DAY)
3								Med. High 500-2000	
2								Med. Low 100-500	
1								Low < 100	

Five numbers plus an assumed zero are used in the rating system. The computer is capable of using negative numbers to indicate positive impacts, but the models were worded in such a fashion so that only positive numbers were used. (This arrangement is not meant to imply that there are no positive impacts of the proposed line. Obviously, the increased transmission of electrical power and increased reliability of the system are generally regarded as positive characteristics of the line. Other positive impacts, such as increased tax base and employment, are not negated in the corridor selection process; however, these potentially positive impacts are not relevant in deciding where the line will be placed.)

The numbers used in the matrix are explained in detail below:

0 - The zero indicates that no relationship exists between a map or map category and a given model, and is assumed everywhere a blank space occurs in the matrix. An example is the fault hazard zone and all models except the sixth. The presence of an active fault has no relationship with transmission line impacts or terrestrial fauna; therefore, it is not considered. A zero does not mean zero impact.

1 - A map category designated with a "one" indicates insignificant impact or constraint from the concern of that model. For example, the "quite stable" category of the slope stability map rates a "one" in the three models in which this map is used. "Quite stable" terrain presents little or no impact to stream sedimentation by landsliding and no greater cost (constraint) in the construction and maintenance of the line due to landsliding.

2 - Two indicates a small but significant impact or constraint.

3 - Moderate impact or constraint can be expected.

4 - Large impact or constraint.

5 - Severe impact or constraint, including absolute prohibition in some cases, such as crossing a primitive area or existing airport.

In corridor selection, the line follows areas of lowest numbers on the map. "Fives" are avoided first, then fours, and so on.

Figure 6-23 shows three hypothetical resource maps for a small area. Each map represents some aspect of the natural environment (second-level map) with numbers assigned to each mapping unit in accordance with the matrix. These three maps are combined to form a hypothetical model (third-level) map.

Figure 6-24 illustrates how these maps can be combined. Map A is the configuration obtained by combining the three maps in Figure 6-23 by assigning the highest value for a given point. For instance, the values for the northwest corner are 5, 2, and 2; therefore, the derived map (Figure 6-24 A) has a value of five assigned to the northwest corner. Likewise, the northeast corner is assigned a value of three.

Another way to combine the three maps is to average the values. Map B in Figure 6-24 is obtained in this manner.

When some resource maps are considered more important in the model than others, the more important maps can be given more emphasis by using a weighted average. Map C (Figure 6-24) is derived by averaging the values of the three maps in Figure 6-23 with the following weights: Map A=10%, Map B=30%, and Map C=60%.

Although the three maps in Figure 6-24 were derived from the same three maps in Figure 6-23, they have quite different configurations.

In choosing the corridor in this study, second-level maps were combined using the highest value method (as in Map A, Figure 6-24). The eight third-level maps (each one representing only one concern or model) were combined using a weighted average (as in Map C, Figure 6-24).

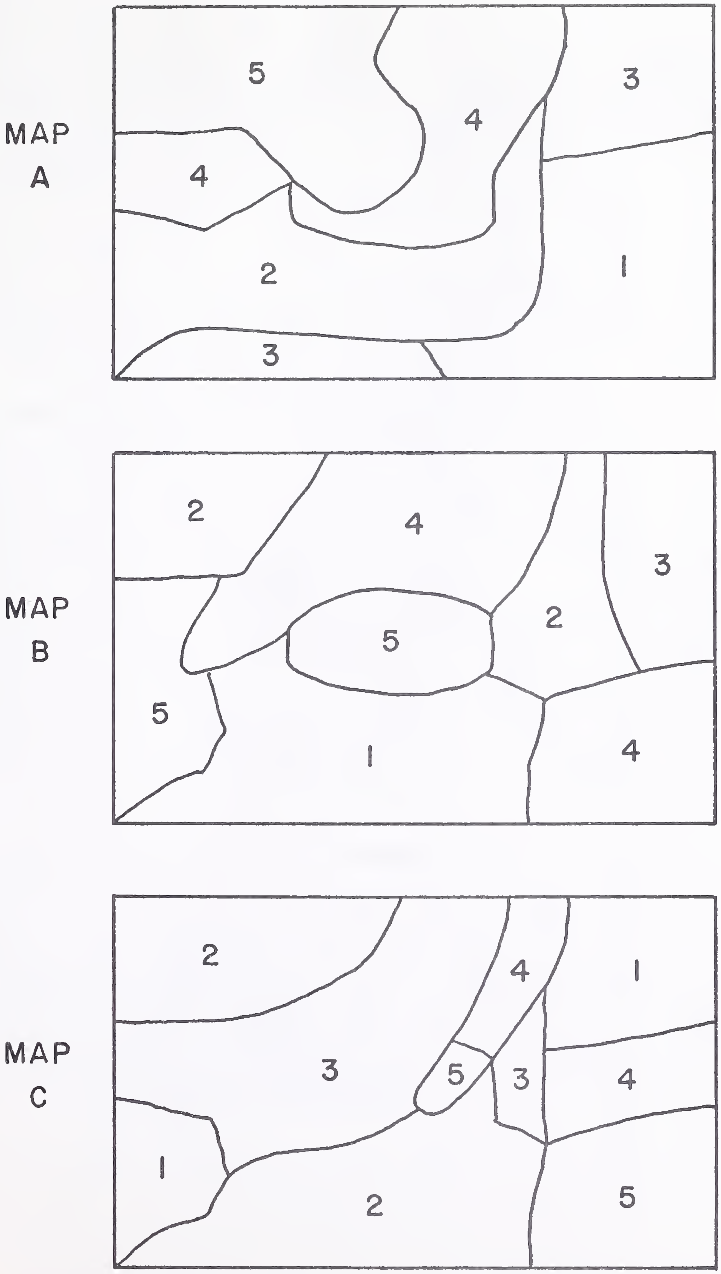
All of the maps discussed in this section, including derivative maps, were generated by a computer process. Due to their physical size (approximately 60" x 50" each) and the detailed information presented on each map, photographically reducing each map and presenting them in this report was considered impractical. All computer-produced maps have been filed at the Energy Planning Division, and interested persons are invited to inspect them.

6.4.4. Corridor Alternatives Selected

Based upon the corridor selection process described here and upon knowledge of the study area of the Energy Planning Division's staff members, a suitable corridor was tentatively determined. This corridor and the corridors presented by the applicant are shown on a translucent overlay contained in the back pocket. (The overlay can be placed over the maps in the publication to determine where the potential corridors lie in relation to natural and cultural patterns.) All potential corridors are shown without preference. Where the corridor derived from this study lies very close to one of the applicant's alternatives, no new corridor was established. It should be kept in mind that the lines on the overlay are much narrower than the two-mile-wide corridor would be shown if drawn to scale.

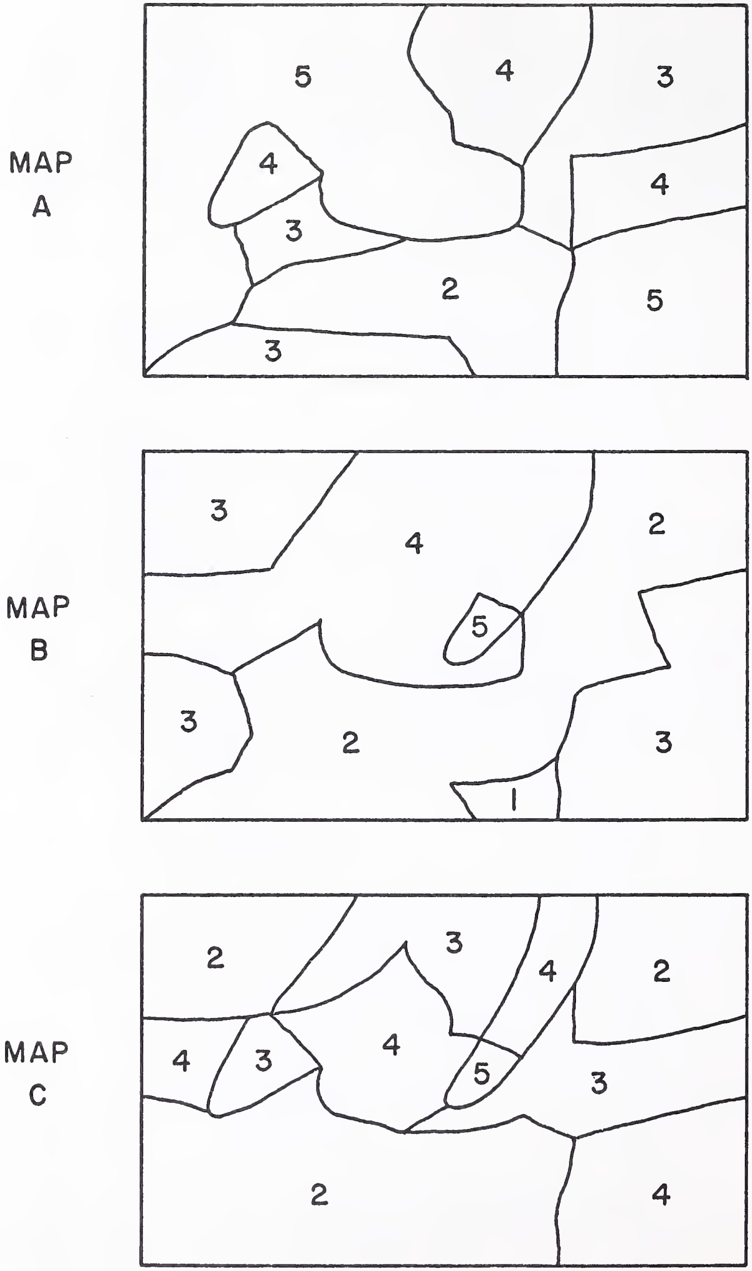
The alternatives shown on the overlay are divided into major and minor segments. Major segments are those between substations and are designated as follows: Dillon-Ennis area, Ennis area-Big Sky, Ennis area-Bozeman, Bozeman-Trident, Bozeman-Clyde Park, Clyde Park-Gardiner, and Bozeman-Big Sky.

Minor segments are designated by letters which appear on the overlay. For instance, the Dillon-Ennis major segment consists of minor segments: A-C, A-B, B-C, B-D, C-Q, Q-D (north and south), and D-L. The other major segments are



THREE HYPOTHETICAL RESOURCE MAPS USED IN CORRIDOR SELECTION

Figure 6-23



THREE DERIVED MAPS OBTAINED BY COMBINING THE THREE HYPOTHETICAL MAPS SHOWN IN FIGURE 6-23

Figure 6-24

similarly divided.

A choice between two of the major segments, Bozeman-Trident, and Bozeman-Clyde Park, will be made for selection of a corridor. If Bozeman is supplied from Trident, there will be no need for another line between Bozeman and Clyde Park. A similar situation applies to the Dillon-Ennis-Big Sky and the Bozeman-Big Sky segments.

FOOTNOTES

CHAPTER SIX

Section 6.3.2.4.

1. Climax refers to the relatively stable, long-lived communities that eventually occur when there is no disturbance (Spurr 1973). Changes in species composition and abundance still occur, but at noticeably slower rates than in "seral" or "successional" stages.

2. Topoedaphic factors refer to the effects of topography and soil.

Section 6.3.3.2.

3. Owned by the U.S. Forest Service, Bureau of Land Management, U.S. Bureau of Reclamation, and other federal agencies.

4. Environmental Quality Council, State of Montana. Third Annual Report, December 1974.

5. According to the Environmental Quality Council's Third Annual Report, 1974, grazing land decreased by 831,321 acres from 1963-1973.

6. Population estimates, U.S. Deptartment of Commerce, Bureau of the Census, May 1975.

Section 6.3.3.3.

7. The four-county labor force is estimated at 27,700. This figure estrapolated from U.S. Water Resources Council, 1972 OBERS Projections, Regional Economic Activity in the U.S., Series E population, vol. 3 (Government Printing Office, Washington, D.C.; 1972); Montana Employment Security Division, Monthly Employment and Labor Force, (Department of Labor and Industry, Helena, Montana; August 1975); Montana Department of Community Affairs, County Profiles for Beaverhead, Madison, Gallatin and Park Counties (Helena, Montana, April 1974).

8. Seasonally adjusted unemployment statistics. Montana Employment Security Division, Monthly Employment and Labor Force (Department of Labor and Industry, Helena, Montana, August 1975.

9. Montana Power Company, written communication, September 12, 1975.

10. Data for 1973, the latest available indicated personal income in excess of 187 million dollars. U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System, (REIS) (unpublished data, 1975).

11. See, for example, "Powell Commissioners Back Proposed Colstrip Plants," *The Missoulian*, January 9, 1975: "The Powell County Commissioners have endorsed proposed Colstrip units 3 and 4 noting that transmission lines from the southeastern Montana generators would cross Powell County and result in an estimated $267,650 in added taxes . . ."

CHAPTER SEVEN

Site-Specific Impact Evaluations

7.1. Introduction

The translucent overlay of potential corridors (in the back pocket) shows tentative alternative corridors of Montana Power Company (MPC) and the Energy Planning Division (EPD). These alternatives are presented without preference and will be evaluated and compared in this chapter. Where an alternative corridor proposed by MPC lies essentially along what appears to be the best corridor (as shown on EPD third and fourth-level maps), no additional corridor was drawn. It should be pointed out that the overlay does not represent the true width of the corridor, which is two miles wide. Closely-spaced corridors overlay considerably.

The entire system of alternatives is divided into the seven major segments of Dillon-Ennis, Ennis-Big Sky, Ennis-Bozeman, Bozeman-Trident, Bozeman-Clyde Park, Clyde Park-Gardiner, and Bozeman-Big Sky. Within each of the major segments are other alternatives in which the line could be built. Alternatives are identified in the text by the letter designations on the intersections shown on the overlay.

Dillon, the Ennis area, Big Sky, Bozeman, and Gardiner are "fixed points" which must in some way be connected by transmission lines. However, the connection between Bozeman dnd Clyde Park can be eliminated if Bozeman is connected with Trident.

The following sections will discuss the impact of each of the alternative segments shown on the overlay in light of the eight concerns (models) previously described in section 6.4.

7.2. Impact on Stream Sedimentation

In the following discussion, the risk for stream sedimentation along requested 161-kV transmission line corridors in the southwestern portion of Montana are discussed. Data used as the basis of these comments has been obtained from maps of road construction suitability, erosion hazard, and vegetation recovery rates, along with the fisheries inventory text and appendix tables. Special attention is given to the location of the requested corridors in relation to the streams, rivers, lakes, and reservoirs of the study area. Of primary consideration is the risk for stream sedimentation resulting from construction activities adjacent to important sport fisheries. Adverse impacts to fisheries associated with sedimentation have been discussed in Chapter Six, section 6.3.2.5.

Six major corridor segments are presented in the following text. Each of these segments are further divided into sub-segments for easier reference to specific area characteristics as they relate to the risk for stream sedimentation from construction activities.

7.2.1. Dillon-Ennis Segment

7.2.1.1. Alternative A-C-Q

This portion of the corridor involves crossing the Beaverhead River north of Dillon and proceeding northward along the terraces of the west slopes of the Ruby Mountain Range to a point near their northern boundary. Wet areas are common along this portion of the Beaverhead River; however, the slope is low and risk for sediment transport to the river is minimal. River flows during spring run-off have been stabilized by the Clark Canyon Dam, and the threat of sediment introduction from the flooding of construction areas and tower sites is greatly reduced.

Numerous intermittent and small perennial streams are bisected by the portion of this corridor that crosses the valley terraces along the Ruby Mountain Range. These streams are characterized by low seasonal flows and little, if any, fishery potential. Along this area, sedimentation risk is confined primarily to areas of terrace breaks. Several of these areas are crossed by the corridor, although careful location of the line and its access and maintenance roads to avoid the areas of higher slopes can minimize much of the sedimentation risk.

7.2.1.2. Alternative Q-D (North and South)

Sport fisheries potential along the Ruby River in this area has been reduced by man-made disturbances. The risk for construction activities to further affect this section of the river appears about equal for both the north and south corridors. Both the corridors cross areas of dissected high valley terraces with high soil erodibility conditions. Proper location of the line to avoid the areas of higher slopes can reduce the threat for sedimentation from these locations. Areas of flood plain crossed by both corridors may require a seasonal construction constraint to further reduce the sedimentation risk in these areas. Along the portion of the northern corridor that crosses Granite Creek, moderately steep to steep, dominantly south-facing slopes present a serious erosion and sedimentation potential. Careful location of roads and tower sites along this area will be necessary to reduce the threat of sedimentation impact to the important sport fisheries of this stream.

7.2.1.3. Alternative A-B

This portion of the corridor involves crossing the Beaverhead River south of Dillon near Poindexter slough, a popular and productive local fishing location. Sedimentation risk in this area is similar to that in alternative

A-C-Q. Slope is low and sediment transport risk appears minimal. Proceeding eastward from the Beaverhead River, the corridor crosses the lower portions of Blacktail Creek, a stream that has an excellent upstream fishery. However, water from the lower portions of this stream is heavily used for irrigation and the sport fishery is severely limited. Risk for sedimentation impacts in this area appears minimal.

7.2.1.4. Alternative B-D

Potential for serious erosion and sedimentation exists along this portion of the corridor. Much of the area has steep slopes, shallow soils, rocky outcrops, and is moderately to heavily dissected. Although most streams in this area have little, if any, sport fishery potential, the major concern is potential transport of sediment downstream into the Ruby River. The Ruby River in this area is currently receiving large amounts of deterimental silt and sediment from other upstream sources. Additional amounts could have serious consequences on the already deteriorated sport fisheries of the river and reservoir.

7.2.1.5. Alternative D-L

The risk for stream sedimentation in this portion of the corridor appears low if areas of higher slope are avoided near stream crossings.

7.2.2. Ennis-Big Sky Segment

7.2.2.1. Alternative D-E-F

These segments of the corridor comprise the most southerly route of the various corridors proposed from Ennis to Big Sky. Approaching the Madison River Valley from the west, the corridor crosses several areas of steep slope with highly erodible soil conditions. These areas are adjacent several small tributaries to the Madison River, and would require careful line location to minimize the risk for sedimentation. These streams have a very limited fishery; however, they are capable of sediment transport downstream to the Madison River during periods of seasonal high flows.

Near the river, the corridor crosses high elevation rolling and undulating residual mountain uplands and terrace breaks with a moderate to high risk for sedimentation. Included is an area of steeply sloping south-facing ridges that should be avoided. As the corridor crosses the Madison River Valley, it encounters areas of low terraces and alluvial flood plains with a wide range in degree of wetness. Sediment risk in these areas is generally low, largely caused by a lack of slope for active transport of the sediment. The fisheries of the Madison River in this area are excellent, although sedimentation sources along the river are increasing. Because of this, it is important that line location and mitigating measures in this area be carefully considered and the most effective procedures implemented.

7.2.2.2. Alternatives L-I-H-G, L-K-G, I-J-G, and K-J

These segments comprise the remaining corridors from Ennis to Big Sky. Crossing the Madison River south of Ennis Lake, the corridors encounter river valley conditions of alluvial flood plains and low terraces similar to the Madison River crossing of alternative D-E-F. Erosion and sedimentation hazard in these areas is generally low, although the area has locations of varying degrees of wetness. A seasonal type of construction constraint to further reduce the sedimentation risk may be necessary.

As the corridors proceed eastward into the Madison Range, they enter a region of forested watersheds with moderately steep to very steep terrain, areas of scree and talus slopes, V-shaped canyons, and moderately to severely erodible soil. Areas with a lower risk for stream sedimentation are present, although these areas are limited, and the risk for sedimentation is high or severe in most locations. Jack Creek and Cedar Creek are the two major streams in this area along the western side of the Madison Mountain Range. These are small mountain streams with limited fisheries, the headwaters of which may contain populations of native cutthroat throut. The risk for sedimentation impact in these headwater areas would be severe from ground disturbance associated with the construction of access and maintenance roads, particularly since the vegetation recovery rate in most of these areas is slow or very slow. A possible loss of important spawning and rearing areas for the native cutthroat trout thought to occur here would be of major concern. The use of helicopter construction techniques in these areas, as well as limiting the amount of ground disturbance from roads, would be critical in order to minimize the high risk for stream sedimentation impacts associated with these corridors.

Nearing Big Sky, the corridors cross the divide of the Madison Range and enter the headwater areas of the Gallatin River. Much of this area has a high to severe risk for stream sedimentation. The West Fork of the Gallatin River has an excellent sport fishery. Effective mitigating measures would be required to protect important sport fish spawning and rearing areas along its headwater tributaries from possible sedimentation impacts.

7.2.3. Ennis-Bozeman Segment

7.2.3.1. Alternative L-M-N

The corridor from Ennis northward to Ennis Lake traverses areas of terrace breaks, alluvial flood plain, and outwash terraces. Among these areas, terrace breaks have the greatest potential for stream sedimentation. Small tributary streams crossed by the corridor generally have limited fisheries. Among these streams, North Meadow Creek has perhaps the most significant significant fishery potential. Placement of the line within the corridor to avoid areas of higher slopes along terrace breaks near North Meadow Creek would be necessary to reduce the threat of sedimentation impacts to this stream.

The more westerly of two possible corridors from point M to point N passes through an area of rolling, moderately steep slopes on residual granite and granitic bedrock. Sediment risk is high for those areas on residual granite, although line placement can reduce the risk by avoiding the areas of higher slopes. Tributary streams with sport fisheries are generally lacking along this corridor, with the exception of Hot Springs Creek. Along the corridor near point N are areas along the Madison River with steep to very steep canyon walls and highly erodible soil. Construction in these areas would make the introduction of large quantities of sediment into the river hard to avoid. The protection of the excellent sport fisheries of the river in this area should be of major concern.

The risk for sedimentation to the Madison River is even greater along the eastern corridor. Much of this corridor crosses areas of dissected steep and very steep valley walls with very highly erodible soil and slow vegetation recovery rates. The high risk for sediment introduction directly into the river along this corridor, and its possible adverse impacts upon the important sport fisheries of the river, would necessitate mitigating measures involving the use of helicopter construction techniques to effectively minimize sedimentation risk.

7.2.3.2. Alternatives N-O (North and South)

At point N the corridor again splits into two possible corridors. The more southerly corridor crosses Cherry Creek, an important sport fishery stream, and its tributary Pole Creek. This area contains moderately steep to steep slopes, some of which are heavily dissected; all of which have highly erodible soil. Vegetation recovery rates in several areas along the corridor near Cherry Creek are very slow, and could add to the threat for prolonged sedimentation problems. Because of this, the protection of the important sport fisheries of this area would be of major concern. Location of the line within the corridor to avoid higher slope areas and the restricting of ground disturbance by roads would be critical in order to reduce the risk for sedimentation impacts in this area. The corridor also crosses Elk Creek and the upper portions of Camp Creek. Elk Creek has a limited sport fishery. Areas of steep and very steep canyon walls near the creek should be avoided to reduce sedimentation risk.

The northerly corridor roughly parallels the Madison River for a portion of its length. Near the river are areas of steep canyon walls similar to those in the eastern alternative of M-N. To reduce the risk for sedimentation impact upon the important sport fisheries of the river, these areas should be avoided. The remainder of the corridor crosses areas in which locating the line within the corridor to avoid areas with higher slopes can reduce the risk for sedimentation impacts along the stream it crosses.

7.2.3.3. Alternative O-R

An increase of stream sedimentation, along with several other factors, is currently a serious problem limiting the fisheries of the Gallatin River and its tributaries in this area. The corridor crosses several channels of the river and numerous irrigation diversions as well as several river tributaries. Of major concern is the risk for introducing additional amounts of sediment into these systems during the construction of the line. The large number of surface water systems in the area provides an effective potential transport for sediment to areas with important sport fisheries. Crossing valley and high valley terraces adjacent these systems would provide for additional sedimentation risk. Location of the line to avoid areas of higher slopes on the terraces, and seasonal construction constraints in areas of flood plain where frequent flooding occur reduces the risk for additional sedimentation impacts upon the fisheries of the area.

7.2.4. Bozeman-Trident Segment (North and South)

The major concern for sedimentation impacts along these corridors involves the crossing and/or close proximity of the line to the important sport fisheries of the West Gallatin and East Gallatin Rivers, as well as crossing numerous irrigation diversion channels and tributaries in the area. Both corridors would have sediment risk potential similar to that for segment O-R. However, the more northern corridor would involve the possible crossing of larger areas of valley terraces. Proper placement of the line within the corridor to avoid high slopes would be critical in order to reduce the risk for additional sedimentation impacts to the area fisheries. Current problems with increasing sedimentation in this area would necessitate careful consideration of mitigating measures to insure that additional mounts of sediment were not allowed to enter the rivers or their tributary streams.

7.2.5. Bozeman-Clyde Park Segment

Alternatives R-S-T-U-V

Areas of steep slopes with a high erosion hazard are common along these corridors. Alternative R-S-T involves the headwater regions of Jackson Creek, an important local sport fishery and major tributary of the East Gallatin River. The location of the line in this area to avoid the higher slopes adjacent the stream, and the minimization of road distrubances will be critical in order to reduce the threat of sedimentation impacts. Alternative T-U-V involves crossing or paralleling Willow Creek, a tributary to the Shields River, for much of its length. Populations of cutthroat trout are found in Willow Creek, and although they do not constitute a major fishery, their populations in streams of this area are declining. Measures to protect any further decline in these populations are necessary. Careful mitigating measures would have to be considered along the Willow Creek drainage to provide for a minimization of sediment and its impacts.

7.2.6. Clyde Park-Gardiner Segment

Along the many alternative corridors from Clyde Park to Gardiner are areas of steep slope and high erosion hazard. The Shields River is currently experiencing serious fishery damage from excessive amounts of sediment being introduced into the river. Effective mitigating measures in this area and along the tributaries to the river would be critical in order to reduce the threat of introducing additional amounts of sediment into the river.

Corridors paralleling the Paradise Valley cross several of the important spawning streams for cutthroat trout from the Yellowstone River. These streams include Cedar, Mol Heron, Tom Miner, Rock, Big, and Mill Creek. Placing the line to avoid the higher slopes adjacent these streams and minimizing the amount of road disturbance in these areas, as well as possible seasonal construction constraints, will be necessary to reduce the threat for sedimentation impacts to the migrating populations of cutthroat trout. The major sport fishery of the Yellowstone River and its tributaries would be of major concern along these corridors.

7.2.7. Bozeman to Big Sky (South)

Alternative RR-Big Sky

The consideration of a two-mile-wide corridor along this section is essentially limited to an area from Bozeman to the mouth of the Gallatin Canyon. Precipitous canyon walls restrict the corridor width through the canyon to that of the varying widths of the canyon floor. The West Gallatin River flows through the canyon, and excellent sport fisheries occur in the river and several of its tributaries. The risk for stream sedimentation in this area would be of major concern.

The risk for stream sedimentation from Bozeman to the mouth of the Gallatin Canyon is similar to that for alternative O-R. Once within the confines of the canyon, the physical nature of the canyon, as well as the West Gallatin River limits the favorable sites for a transmission line. This, along with present sedimentation problems in several tributaries of the river, (primarily the West Fork Portal and Squaw Creek) make mitigating measures in this area critical for minimizing additional stream sedimentation.

An MPC 69-kV transmission line currently supplies power to Big Sky, via the Galaltin Canyon. Upgrading this line to 161-kV along the current right-of-way, rather than the construction of an additional line in this area would substantially reduce the risk for additional stream sedimentation. When compared with the various alternative corridors proposed to enter Big Sky from the west, the upgrading of the existing Gallatin Canyon line would be less likely to produce significant stream sedimentation.

7.3. Impact on Potential Range Productivity

All corridors identified on the overlay in the back pocket have been evaluated with respect to the vegetation inventory, which consists of a vegetation type map (in the back pocket) and the pertinent information for each type. This inventory is explained in section 6.3.2.4.

The 1:250,000 scale corridor map can be overlain on the Vegetation Type map to see which habitat type will be affected by the various possible corridors. To aid in a comparative assessment of the various possible corridors on range productivity, the amount of rangeland in each of the three highest productivity categories (i.e., those rated 3, 4, or 5 in potential productivity on Table 6-3) have been estimated for each corridor. A two-mile corridor does not permit a truly precise quantitative assessment of impact, but a general quantitative comparison seems warranted and desirable. The approximate miles of corridor in each alternative have been listed for potential productivity categories 3, 4, and 5, with 5 being most productive. The corridor that will have the least impact for each segment has also been identified.

It is worth noting that a route with little impact on rangeland may have a greater impact on agricultural land. Productivity of agricultural and rangeland cannot be directly compared because agricultural land typically receives energy supplements in the form of irrigation water and fertilizer. However, in the overall assessment of impact on food production, this would be taken into account.

7.3.1. Dillon-Ennis Segment

Alternatives Dillon-B and Dillon-C pass through bluebunch wheatgrass climax rangeland and a cottonwood riparian community, both of which have grazing value.

Alternative B-C passes through bluebunch wheatgrass rangeland and a greasewood community. In combination with alternative Dillon-B, this route will have a greater impact on rangeland than the shorter Dillon-C alternative.

Alternative B-D passes through a good deal of bluebunch wheatgrass and Idaho fescue rangeland, and smaller areas of mountain mahogany and aspen.

Alternative C-Q is located predominantly in bluebunch wheatgrass rangeland and, to a lesser extent, greasewood.

Both Q-D alternatives pass through bluebunch wheatgrass rangeland and some Rocky Mountain juniper communities. In addition, alternative Q-D north passes through a mountain mahogany community.

Alternative D-L is located mainly in Idaho fescue rangeland (much of which contains big sagebrush) and passes through small areas of bluebunch wheatgrass and needle and thread climax. This alternative also traverses the rigorous mountain mahogany/bluebunch wheatgrass habitat type.

The impact of the various corridors can be evaluated using the chart below.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
Dillon-B	0.5	3	0
Dillon-C	1	4.5	0
B-C	0	3.5	0
B-D	2.5	19	9
C-Q	0	17	0.5
Q-D north	1	4.5	2.5
Q-D south	1	5.5	2
D-L	0.5	1	6.5

The preferred corridor route for this segment is Dillon-C-Q north-D-L.

7.3.2. Ennis-Big Sky Segment

Alternative D-E is predominantly located in the relatively moist and productive Idaho fescue series, and also traverses Douglas fir/Idaho fescue habitat type, which probably produces the most graninoid forage of all forest types.

Alternative E-I passes through the dry needle and thread/blue gramma habitat type and a strip of riparian vegetation with some grazing value. A small area of Idaho fescue grassland is also incorporated in this corridor.

Alternative E-F is located in a number of forest habitat types with grazing potential and also some bluebunch wheatgrass rangeland.

Both L-K alternatives pass through bluebunch wheatgrass climax rangeland and the Douglas fir/Idaho fescue habitat type. The southern route also affects some needle and thread climax grassland.

Alternative L-I is located mainly in needle and thread climax rangeland, where productivity ranges from under 200 to slightly over 800 air dry lbs per acre/year.

Alternatives K-G (north and south), K-J, I-J, J-G, I-H, H-G, H-F, and F-G are located primarily in forest habitat types, some of which are rated in category 3 for range productivity. Alternative I-H also passes through some fescue rangeland and alternative F-G through a large clear-cut and some scree.

The impact on potential productivity can be assessed using the chart below.

Alternative	Approximate Miles In Productivity Category 3 (moderate)	4 (high)	5 (very high)
D-E	0.5	0	7.5
E-I	5.5	1	1
E-F	3	3	3
L-K north	2.5	3	0
L-K south	3.5	1	0
L-I	5.5	0	0
K-G north	1	0	0
K-G south	4	0	0
K-J	1.5	0	0
I-J	1	0	0
J-G	1	0	0
I-H	1	0	0.5
H-G	0	0	0
H-F	0	0	0
F-G	4	0	1

The corridor route that will have the least impact is L south-K north-G.

7.3.3. Ennis-Bozeman Segment

Alternative L-M traverses mainly Idaho fescue and bluebunch wheatgrass rangeland, and a few small mountain mahogany communities.

Both M-N corridors pass through Idaho fescue rangeland. Alternative M-N east also crosses an aspen community and the slow-to-recover mountain mahogany/bluebunch wheatgrass habitat type.

Alternative N-O north crosses Idaho fescue rangeland and lesser amount of drier needle and thread and bluebunch wheatgrass climax rangeland. Rocky Mountain juniper communities and the hot, dry limber pine/bluebunch wheatgrass habitat type will also be affected.

Alternative N-O south passes through fescue and wheatgrass rangeland, and dry forest and shrubland habitat types. Some aspen communities are located in this corridor.

Alternative O-R is located predominantly in agricultural land, but areas of Idaho fescue rangeland and a cottonwood riparian community will also be affected.

The impact on productivity of the various alternatives is listed on the chart below.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
L-M	0	4.5	5.5
M-N east	0.5	0	3
M-N west	0	0	5
N-O north	2	1	5.5
N-O south	2	2.5	5
O-R	1	0	1

The best corridor route for this segment is L-M east-N north-O-R.

7.3.4. Bozeman-Clyde Park Segment

Alternative R-S traverses areas of Idaho fescue climax rangeland and Douglas fir forest.

Alternative S-U is confined mainly to Douglas fir forest, although some fescue rangeland must be traversed near U.

Alternative S-T is located largely in the Douglas fir/pinegrass habitat type. Pinegrass is cropped by livestock in the early part of the growing season.

Alternative T-U crosses some fescue rangeland and a clearcut; otherwise, it traverses Douglas fir forest.

Alternative U-V is located in relatively productive Idaho fescue rangeland.

Alternative T-V will affect some fescue rangeland. In another portion of this alternative, either Douglas fir forest or some logged areas must be traversed.

Impacts on productivity are summarized in the chart below.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
R-S	3.5	0	3.5
S-U	4.5	0	2.5
S-T	3.5	0	0.5
T-U	3	0	1
U-V	0	0	6.5
T-V	4.5	0	6.5

The best corridor route for this segment is R-S-U-V. This route has an additional advantage: part of the Clyde Park-Gardiner line could use a portion of this corridor, thus minimizing impacts. On the other hand, a Bozeman-Trident corridor would substitute for this line.

7.3.5. Clyde Park-Gardiner Segment

Alternatives V-U, V-W, W-X, and X-Y are located predominantly in the relatively productive Idaho fescue series rangeland.

Alternative U-Z passes through fescue climax rangeland in addition to some Douglas fir forest and a mountain mahogany community.

Alternative X-Z passes through fescue rangeland, Douglas fir forest of grazing value, and a long, narrow strip of the rigorous limber pine/bluebunch wheatgrass habitat type.

Alternative Z-CC traverses fescue rangeland and Douglas fir forest. Alternative Z-BB is similar, but may also affect an aspen community.

Alternative BB-CC passes through bluebunch wheatgrass climax rangeland and an aspen community with grazing value.

Alternative CC-DD will mainly affect bluebunch wheatgrass and needle and thread climax rangeland and some Rocky Mountain juniper communities.

Alternative W-Y is located mainly in Idaho fescue climax rangeland, and also crosses a cottonwood community twice.

Alternative Y-AA is largely in forested areas, which have low grazing values relative to rangeland.

Alternative AA-BB passes through Douglas fir, Rocky Mountain juniper, sagebrush, and Idaho fescue types.

Alternative AA-DD traverses a good deal of bluebunch wheatgrass and needle and tread rangeland and smaller Rocky Mountain juniper and sagebrush communities.

Alternative DD-EE crosses areas of wheatgrass and fescue rangeland, a Rocky Mountain juniper community, and a narrow poplar community.

Alternative EE-FF east passes through fescue and wheatgrass rangeland, smaller areas of sagebrush and aspen, and the Douglas fir/Idaho fescue habitat type, which has high grazing potential for a forest type.

Alternative EE-FF west is located mainly in productive rangeland of the Idaho fescue series.

While alternative FF-Gardiner may traverse small grassland areas, it is located mainly in sagebrush shrubland and Douglas fir/Idaho fescue forest.

The impacts on productivity of the alternatives can be evlauated using the following chart.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
V-U	0	0	6.5
U-Z	2	0	5.5
V-W	0	0	6
W-X	0	0	4.5
X-Z	2	0	3.5
Z-CC	3	1	5.5
Z-BB	3	0	3
BB-CC	0.5	2	0.5
CC-DD	1	2	0.5
W-Y	1	0	4.5
X-Y	0	0	3
Y-AA	1	0	0
AA-BB	1.5	0	0.5
AA-DD	5.5	5.5	0
DD-EE	0.5	3	1
EE-FF east	2	4	3.5
EE-FF west	1	0.5	8
FF-Gardiner	9	0	1

Considering this segment alone, the preferred route is V-W-Y-AA-BB-CC-DD-EE east-FF-Gardiner. If alternative V-U is used in going from Bozeman-Clyde Park and the impact of alternative V-U shared by the two segments, then corridor route V-U-Z-BB-CC-DD-EE east-FF-Gardiner will still have a greater impact than the preferred route.

7.3.6. Bozeman-Trident Segment

Both R-P alternatives are located primarily in agricultural land and cross poplar communities.

Alternative P-Trident passes through bluebunch wheatgrass climax rangeland and a Rocky Mountain juniper community.

These alternatives are compared below.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
R-P north	1	0	0
R-P south	.5	0	0
P-Trident	.5	4.5	0

The preferred route for this segment is R south-P-Trident. This segment is a possible alternative to the Bozeman-Clyde Park segment. Thus, a comparison of the best route for each segment is desirable.

	Approximate Miles in Productivity Category 3 (moderate)	 4 (high)	 5 (very high)
Bozeman-Clyde Park R-S-U-V	8	0	12
Bozeman-Trident R south-P-Trident	1	4.5	0

7.3.7. Bozeman-Big Sky Segment

Alternative RR-SS passes through a number of dry to mesic types in the Douglas fir series. These types have grazing value and often exhibit high grass coverages. Productive areas of Idaho fescue rangeland are also traversed.

If the existing line is upgraded rather than building an additional line, disruption to vegetation and loss of productive land to structural and associated use would be minimal. If another line is built near the present line making maximum use of roads and other extant features ancillary to line construction, impact to vegetation would be far less than in areas where a line does not presently exist.

This chart lists the amount of land in the various productivity categories that will be affected by this segment and does not take into account the possibility of using existing facilities.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	 4 (high)	 5 (very high)
RR-SS	18	0	4.5

7.4. Impact on Potential Wood Productivity

A comparison of the impacts of all identified possible corridors was made using the Vegetation Types map and the associated potential wood productivity ratings found in the Vegetation Type Characterization Charts (Table 6-3). The Vegetation Type map can be overlain on the corridor map to see which types may be affected. The amount of habitat types with productivity ratings of 3, 4, or 5 (with 5 being most productive) have been approximated for each alternative. Although a precise quantitative comparison cannot be compiled for a two mile corridor, these data are useful for comparison of alternatives and identification of the route that will have the least impact on wood production. Moreover, trade-offs of wood production for other values can be reasonably evaluated using these data.

7.4.1. Dillon-Ennis Segment

The only forest types affected by the corridors from Dillon-Ennis are the cottonwood-willow communities found along waterways. Conifers are usually prevented from reaching maturity in these areas due to periodic flooding. Potential productivity is high because of moisture availablity, but these areas are seldom managed for wood production at present.

Impacts on productivity can be evauated using the chart below.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5(very high)
Dillon-B	0	0	0.5
Dillon-C	0	0	1
B-C	0	0	0
B-D	0	0	0.5
C-Q	0	0	0
Q-D north	0	0	1
Q-D south	0	0	0.5
D-L	0	0	0

The routes which will have least impact on wood production are Dillon-B-D-L and Dillon-B-C-Q south-D-L.

7.4.2. Ennis-Big Sky Segment

Alternative D-E is located predominantly in rangeland, and only small areas of the Douglas fir/Idaho fescue habitat type will be affected.

Alternative E-I crosses a cottonwood type at the Madison River.

Alternative E-F also crosses a cottonwood community and traverses Douglas fir and subalpine fir types toward F. Some fragile timberline and near-timberline types would be affected by this alternative.

Both L-K alternatives cross riparian cottonwood communities and the Douglas fir/Idaho fescue habitat type. Alternative L-I crosses the same cottonwood community.

Both K-G alternatives pass through types of the Douglas fir and subalpine fir series. Alternative K-G north also passes through a sizeable area of scree.

Alternative K-J passes through the Douglas fir/pinegrass and subalpine fir/pinegrass habitat types.

Alternatives I-J, J-G, H-G, and F-G cross areas in the Douglas fir and temperate subalpine fir series.

Alternative I-H traverses Douglas fir and subalpine fir types, including the subalpine fir-whitebark pine/grouse whortleberry habitat type, which is relatively fragile, and the even more rigorous and fragile whitebark pine habitat type.

Alternative F-G crosses areas in the subalpine series, including the subalpine fir-whitebark pine/grouse whortleberry habitat type. Logged areas and some scree are also traversed by this alternative.

A comparison of the impact on productivity of each alternative follows.

Alternative	Approximate Miles in Productivity Category		
D-E	0.5	0	0
E-I	0	0	0.5
E-F	1.5	3	0.5
L-K north	1.5	0	1
L-K south	1.5	0	0.5
L-I	0	0	0.5
K-G north	0	2	4.5
K-G south	1.5	4.5	3
K-J	0	1.5	1
I-J	1	1	1
J-G	0.5	2	3
I-H	1.5	1	0
H-G	2.5	2	1
H-F	2	3	0
F-G	0	3	2

Of the possibilities identified, the route that will have the least impact on wood productivity is L-I-H-G.

7.4.3. Ennis-Bozeman Segment

There will be little impact on wood productivity in this segment. Alternatives M-N east and N-O south may pass through aspen communities. Alternatives M-N east also crosses the Douglas fir/Idaho fescue habitat type. Alternative O-R must cross a poplar community.

The impacts are summarized in this chart.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
L-M	0	0	0
M-N east	0	0	0.5
M-N west	0	0	0
N-O north	0	0	0
N-O south	1	0	1
O-R	0	0	1

The best route for this segment is L-M west-N north-O-R.

7.4.4. Bozeman-Clyde Park Segment

Alternatives R-S, S-U, S-T, T-U, and T-V cross dry to mesic habitat types in the Douglas fir series. The magnitude of impacts on productivity can be assessed using this chart.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
R-S	0	2.5	0
S-U	0	5	0
S-T	0	3.5	0
T-U	0	3	0
U-V	0	0	0
T-V	0	3.5	0

The corridor for this segment that will have least impact on wood productivity is R-S-U-V. The impact on wood productivity of this segment is far greater than the impact of the corridor from Dillon-Ennis-Bozeman.

7.4.5. Clyde Park-Gardiner Segment

Alternatives V-U, V-W, W-Y, CC-DD, X-Y, and AA-DD do not pass through forest communities.

Alternatives U-Z, X-Z, Y-AA, AA-BB, EE-FF (east and west), and FF-Gardiner pass through habitat types in the limber pine and Douglas fir series.

Alternatives Z-CC, BB-CC, W-Y, and DD-EE cross poplar communities. Alternatives Z-CC and W-Y also traverse types in the Douglas fir series.

The impacts on productivity of each alternative can be compared using this chart.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
V-U	0	0	0
U-Z	0	2	0
V-W	0	0	0
W-Y	0	0	0
X-Z	0	1.5	0
Z-CC	1	2	0.5
Z-BB	1	1	0
BB-CC	0	0	0.5
CC-DD	0	0	0
W-Y	0	0.5	1
X-Y	0	0	0
Y-AA	0	1	0
AA-BB	0.5	1	0
AA-DD	0	0	0

continued on next page

Alternative	Approximate Miles in Productivity Category (continued) 3 (moderate)	4 (high)	5 (very high)
DD-EE	0	0	0.5
EE-FF east	1	0	0
EE-FF west	0.5	0.5	0
FF-Gardiner	5	0	0

Considered alone, the corridor route with least impact on wood productivity is V-W-X-Y-AA-DD-EE east-FF-Gardiner. Since alternative U-V may be used in the Bozeman-Clyde Park segment, it seems reasonable to split the impact for that segment between the Bozeman-Clyde Park and Clyde Park-Gardiner segments and compare the results with the preferred segment.

	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
V-W-X-Y-AA-DD-EE east FF-Gardiner	6.5	1	0.5
V-U-Z-BB-CC-DD-EE east FF-Gardiner	7	3	1

7.4.6. Bozeman-Trident Segment

Both R-P alternatives and the P-Trident alternative must cross riparian poplar communities. Their relative impacts on productivity are listed in the following chart.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
R-P north	0	0	1
R-P south	0	0	0.5
P-Trident	0	0	0.5

The best route for this segment is R south-P-Trident. Since this route is an alternative to the Bozeman-Clyde Park segment, the best routes for the two segments should be compared.

	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
Bozeman-Clyde Park R-S-U-V	0	7.5	0
Bozeman-Trident R south-P-Trident	0	0	1

7.4.7. Bozeman-Big Sky Segment

Alternative RR-SS passes through a good deal of land in the Douglas fir series, mainly the Douglas fir/snowberry, Douglas fir/pinegrass, and Douglas fir/Idaho fescue habitat types. Some aspen communities may also be affected.

By upgrading the existing line, or using the existing right-of-way if another line is built, loss of productive land and construction caused disruptions to vegetation will be minimal.

The following chart lists the amount of land in the various productive categories and does not take into account the possibility of using existing facilities.

Alternative	Approximate Miles in Productivity Category 3 (moderate)	4 (high)	5 (very high)
RR-SS	4.5	14.5	1.5

7.5. Impact on Terrestrial Fauna

The following discussion compares potential impacts on terrestrial fauna for the alternative corridors shown on the overlays in the back pocket. The nature of these potential impacts has been discussed in detail in section 6.3.2.5. and will not be repeated here. Rather, those corridor segments where the potential exists for adverse impacts which may significantly affect wildlife populations or habitat will be identified. It should be emphasized at this point that many of these potential adverse impacts to wildlife can be prevented, or at least greatly reduced, if the mitigating measures are followed and if the center-line is carefully chosen within the final corridor.

Not all species which may be affected by transmission line construction within a given corridor segment are mentioned below. For example, although all corridors shown include mule deer habitat and nearly all include some mule deer winter range, transmission line construction and operation within these corridors are not expected to significantly affect mule deer populations; hence, potential impacts to mule deer are not discussed.

All segments contain at least a small amount of sage grouse or sharptail grouse habitat. However, the winter and breeding distribution of these birds is little known in this area, and it is not known whether any of the alternative corridors include strutting or dancing grounds. Alternative B-D includes known sage grouse winter range, but the amount of winter range crossed by other alternatives is unknown. Construction near strutting or dancing grounds in spring could interfere with breeding activity, and may increase mortality of these birds due to wire strikes. Adverse impacts to sage or sharptail grouse could be minimized if the final corridor is surveyed for breeding sites in spring, and the center-line selected accordingly.

Nearly all segments include potential golden eagle nesting habitat, but the exact location and recent status of nest sites is well known in only a few areas. Table 7-1 summarizes the number and status of known golden eagle nest sites for several corridor segments.

Corridor segments and alternatives having potential for significant adverse impacts to other wildlife species are identified below.

7.5.1. Dillon-Ennis Segment

Alternative B-D skirts the lower fringe of the winter range used by elk which summer in the Gravelly Mountains, and the northern alternative from D to Q includes a small amount of winter range used by elk which summer in the Tobacco Root Mountains. Construction through these areas in late winter and early spring could displace elk, increasing stress and the associated probability of overwinter losses, especially during severe winters. Alternative D-L includes part of the winter range used by moose in the Tobacco Root Mountains, but the number of moose using this area is small, and damage to wintering moose or their habitat is expected to be minimal. The incidence of wire strikes by waterfowl and shorebirds may increase if the line is sited within alternative B-D near Ruby Reservoir; however, the poles may provide osprey nest sites and extend osprey breeding distribution into this area.

7.5.2. Ennis-Big Sky Segment

The Ennis-Big Sky segment presents the greatest potential for adverse impacts to large mammals. All alternatives connecting Ennis and Big Sky cross a considerable amount of roadless land, and present the possibility of access-related impacts as discussed in section 6.3.2.5. These include short-term displacement during construction, and long-term displacement resulting from human access. In addition, long-term habitat alteration will result from the presence of a cleared corridor if conventional construction methods are employed.

Although this impact statement addresses transmission line siting and not road or highway siting, in this particular area the two are so intimately connected that they must be discussed together. The access roads used to facilitate transmission line construction may or may not be all-weather roads open to the public. The "opening up" of this roadless area by a transmission line, whether accompanied by the access road, may supply the impetus for construction of a through road. In addition, since road siting involves an entirely different set of criteria and constraints than transmission line siting, the two may follow widely different routes, affecting a much greater total area. The impacts associated with the roading of a wilderness-like area have been discussed in section 6.3.2.5.

The high, moist drainage heads within the Madison Range, particularly those crossed by segments K-G, K-J-G, I-H-G, and the upper arm of E-F are preferred summer-fall elk habitat. Construction activities and the increase

TABLE 7-1

GOLDEN EAGLE NESTS KNOWN TO LIE WITHIN OR NEAR ALTERNATIVE CORRIDORS

Corridor	No. Recently Active (With Dates of Most Recent Known Activity)	No. Supernumerary or not known to be active
Dillon-Ennis Segment		
Alternative D-L	1 (1973-4)	3
Alternative D-E	-	1
Ennis-Big Sky Segment		
Alternative L-K (both)	1 (1974)	-
Alternative K-G (northern)	1 (1973)	1
Alternative K-G (Jack Cr.)	1 (1972)	1
Alternative I-H	1 (1974)	2
Alternative E-F	1 (1974)	1
Clyde Park-Gardiner Segment		
Alternative U-V	2 (1962-4; 1967-8)	-
Alternative W-X	1 (1965-8)	-
Alternative Y-AA	1 (1967)	-
Alternative Z-CC	1 (1967)	-
Alternative DD-EE	-	1
Alternative EE-FF (western)	1 (1974)	1
Alternative FF-Gardiner	1 (1974)	3

Source: Baglein 1975, Reynolds 1969, McGahan 1968 in human use resulting from easier access to the area are quite likely to displace elk from the affected drainages. Also, all segments from Ennis to Big Sky cross elk winter range, and may result in displacement and increased stress of elk using the area unless construction is restricted to the summer-fall months. The clearing of a corridor through elk summer range is not expected to significantly increase the amount of forage available to the elk.

Segments K-G, J-G, I-H-G, H-F, and the upper arm of E-F cross a portion of the last remaining suitable grizzly bear habitat in southwestern Montana. The exact nature of the grizzly bear population using this area is presently unknown (although studies of these bears are currently underway), and hence the magnitude of impacts upon the population resulting from the proposed facility cannot be predicted. Since there is scant baseline data on grizzly bear use of the area prior to the advent of Big Sky, the effects of Big Sky and the accompanying increase in human use of the area on the grizzly bear are unknown. It appears that very few bears presently use the area in question; the Spanish Peaks-Cedar Mountain area may be regularly used by as few as one sow with cubs. The intrusion of a transmission line and/or access road into this roadless habitat may provide enough additional degradation of optimal grizzly bear habitat, as perceived by the bears themselves, to permanently eliminate the use of this area by grizzlies. However, the present level of bear use is so low it would be impossible to conclusively link the demise of the grizzly from this area to Big Sky, access roads, transmission lines, increased human use, or any combination of these factors. In any case, in order to prevent the possibility of further depletion of grizzly habitat in southwestern Montana, it would be best to delay any decisions regarding transmission line or road construction through this area until the findings of the Interagency Grizzly Bear Study are available.

Segments L-K-J, L-K-G, L-I-H, H-F, and F-G cross known moose wintering areas. However, impact to moose habitat will be significat only if extensive clearing of willow bottoms occurs where access roads parallel streams. Displacement of wintering moose can be avoided by confining construction activities through wintering areas to summer and fall months.

Segments G-K and F-G include portions of the edge of bighorn sheep habitat, but no known wintering areas. Segment L-K-G includes a small amount of the lower fringe of mountain goat winter range along the steep cliffs north of Jack Creek. Construction through these areas in winter or spring is likely to displace wintering animals.

Alternatives L-K and L-I cross the Madison River south of Ennis Lake, an important waterfowl use area; construction of the line here is likely to increase waterfowl mortality due to wire strikes. If the line is constructed in this area during spring and early summer, disturbance to nesting Canada geese is likely to occur.

7.5.3. Ennis-Bozeman Segment

Construction of this segment is not expected to have significant adverse effects upon wildlife. The southern alternative N-O includes a small amount of elk and moose winter range, but impacts to wintering animals can be prevented by restricting construction to summer and fall.

7.5.4. Bozeman-Clyde Park Segment

Although alternative R-S-U includes moose winter range, impacts are expected to be minor since this corridor parallels an existing transmission line. Impacts to wintering moose are more likely within alternatives S-T, T-U, and T-V, which include creek bottoms within coniferous forests.

7.5.5. Clyde Park-Gardiner Segment

Alternative Z-BB-CC includes one active prairie falcon nest site. Crossing the Yellowstone River (alternative EE-FF) may affect a small amount of great blue heron nesting habitat, namely, the tall mature cottonwoods which line the riverbanks, as well as waterfowl nesting habitat. A recently abandoned heron rookery is located on the Yellowstone River near alternative EE-FF, but the present nesting distribution of herons in this area is unknown. Alternatives Z-CC, BB-CC, CC-DD, and EE-Gardiner include part of the lower fringe of winter range used by elk summering in the Gallatin and Absaroka Mountains; alternative Z-CC also crosses a known elk calving area. A portion of bighorn sheep winter range along the steep west slopes of Yankee Jim Canyon is included in alternative FF-Gardiner; construction of the line through this area during winter or spring could displace wintering sheep, increasing stress and the probability of overwinter mortality.

7.5.6. Bozeman-Trident Segment

The extreme northern end of this segment passes near a large rookery, used by great blue herons and double-crested cormorants, along the Gallatin River between Logan and Trident. Construction near this site in March or April could result in abandonment of the rookery. The southern alternative P-R paralles an interstate highway, a railroad, and a paved highway, and includes many residential areas; wildlife impacts within this corridor would be negligible. The northern alternative, however, follows the East Gallatin River, and wire strikes by waterfowl using this portion of the river may increase if the line is constructed within this area.

7.5.7. Bozeman-Big Sky Segment

Although alternative RR-SS passes through the winter ranges of elk, mule deer, bighorn sheep, and mountain goat, as shown on the inventory maps, impacts to these species resulting from transmission line construction and operation in Gallatin Canyon are expected to be insignificant, especially if construction is confined to the summer and fall months. The Gallatin Canyon area includes a paved highway, and is already heavily used by vehicles and humans; animals using the area are either already displaced from the immediate vicinity of the highway by traffic or are habituated to the traffic (see, for example, Figure 6-5). Construction activities in the Canyon and near the highway are not expected to significantly increase existing levels of disturbance of these animals, and, since new access roads need not be constructed, the impacts associated with the roading of roadless areas will not occur. Upgrading of the existing Bozeman-Big Sky line to 161-kV within the same right-of-way is less likely to adversely affect wildlife than is construction of a new, separate line, as upgrading would not require extensive right-of-way clearing.

7.6. Cost Comparisons of the Alternative Corridors-Intorduction

The cost of transmission line construction and maintenance is determined by many factors, including length, design of the structures, and the nature of the terrain over which the line must pass. The costs also vary depending upon the construction methods used. Therefore, cost comparisons of the different corridors are highly generalized. Exact cost estimates cannot be made based only on corridors, but some comparisons for various corridors can be made.

Except for the corridors into Big Sky, terrain that would be particularly expensive to build across is generally avoided. Examples of the kinds of terrain that would significantly add to costs are: 1) steep, rugged, or mountainous regions, 2) urban-suburban areas, 3) prime agricultural land. Even these classes of terrain often contain discontinuities which may allow a transmission line to pass without excessive cost; however, not all such potential center-lines have been identified in this study. Comparisons will be stated on the basis of the two-mile-wide corridors. Small segments be compared only if significant differences exist.

7.6.1. Dillon-Ennis Segment

Although corridor A-B-Q (south) passes over the Ruby Range, the truly mountainous portion of the range is avoided. Where this segment crosses the range, the terrain is not particularly rugged and would not constitute a major obstacle in crossing with conventional construction equipment. However, this corridor is more rugged than the C-Q-D corridor in parts and does lie at a higher elevation. The existing accessibility along corridor C-Q-D is generally easier than B-D (south) which would favor the northern corridor. However, the northern corridor crosses more agricultural land, which would raise the price of right-of-way acquisition. There is little apparent difference in costs in avoiding Dillon.

In crossing from the Ruby River Valley to the Madison Valley, all alternative corridors pass through point D, near Virginia City.

7.6.2. Ennis-Big Sky Segment

Corridor D-E, and D-E-F especially, add excessive length to the line. If either of the corridors are used, the connecting substation must be built at D or E. A substation at D may result in access difficulties in the winter and a substation at E would increase the length of the Ennis-Bozeman segment. Corridor D-L is the most direct segment. All corridor segments from L and E to Big Sky pass over the Madison Range, an area of steep slopes, unstable bedrock, and no existing roads. Whether conventional construction methods or helicopters are used, this corridor would be expensive to build in. The proper use of helicopters here may be cheaper than conventional construction. Segments L-K (south) and K-G (south) are the shortest way of connecting Ennis and Big Sky.

7.6.3. Ennis-Bozeman Segment

Of the alternative corridors between Ennis and Bozeman, there seems little difference in the inherent cost between the segments.

7.6.4. Trident-Bozeman and Bozeman-Clyde Park Segments

Since only one of these segments will be built, a comparison of the alternatives is in order. The Trident-Bozeman segment is likely to be more expensive for three reasons:

1) It is the longer of the two segments
2) Right-of-way acquisition may be more costly
3) If this segment is used, the substation at Trident will have to be upgraded.

Even though the Bozeman-Clyde Park segment passes over some mountainous terrain, a transmission line and right-of-way already exist there.

7.6.5. Clyde Park-Gardiner Segment

Although there are many minor segments in the northern half of this portion of the line, there are no outstandingly expensive or inexpensive corridors. As one progresses toward Gardiner, the alternatives become fewer until only one corridor is reasonable from a cost point of view. Corridor segments W-Y and W-X-Y pass near the city of LIvingston; however, the corridor allows enough flecibility to generally avaoid crossing high-cost real estate. From the Shields River area (Clyde Park) to the Paradise Valley by any minor segment involves the crossing of some steep or rugged terrain and additional expense may be incurred.

7.6.6. Bozeman-Big Sky

From the Bozeman area to the mouth of the Gallatin Canyon, costs would be comparable to other segments of the line, but the physiography of the

Gallatin Canyon presents unique problems. Unlike broad valleys and the like, a new transmission line would have to compete with an existing line, a road, the river, and existing land use patterns in a very narrow space. An alternative to building a new transmission line would be to upgrade the existing 69-kV line (for reasons other than cost). Because service at Big Sky may have to be interrupted during this construction period, a work-force larger than usual may be required. However, studies to best determine the cheapest method of upgrading the 69-kV line or to build a new line on essentially the same right-of-way remain to be completed. It is not apparent at this time whether it would be cheaper to build the transmission line into Big Sky from Ennis or Bozeman - especially when unusual methods of construction are necessary to mitigate environmental damage.

7.7. Comparison of Reliability of Alternative Corridors

7.7.1. Introduction

Reliability, as used in this section, refers only to the functioning of a segment of transmission line - not system reliability. In this context, reliability is a measure of the performance of the line in the face of physical hazards such as weather, landsliding, and vandalism. A well designed and constructed transmission line is quite reliable; however, all other things being equal, some corridors may present more hazard to a line than some others. Although reliability was weighted lightly in the corridor selection process, it was considered, and the major segments will be compared below.

7.7.2. Dillon-Ennis Segment

The Ruby Range is bordered and crossed by several potentially active faults. Corridor C-Q-D skirts the faults bordering the northern end of the range, whereas B-D (south) crosses one of the traverse faults. In the event of a major earthquake along any of these faults, the transmission line may be damaged. No other outstanding hazards exist in this segment.

7.7.3. Ennis-Big Sky Segment

This segment crosses one of the largest and most active faults in southwestern Montana where the alternative corridors pass into the Madison Range. The portion of the Madison Range south of the Spanish Peaks also contains the bedrock, slope, and moisture conditions which form unstable slopes. Considering only earth processes (not climatic), this segment is the most hazardous in the entire study. Insufficient data exist to compare climatic hazards on this segment to other corridors. The higher elevations and greater snowfall in the Madison Range make access more difficult during the winter; thus, affecting the time it would take to make repairs if the line should fail.

7.7.4. All Other Major Segments

All other segments contain a variety of hazards of which none are particularly outstanding. Good design and selection of a center-line within the two-mile-wide corridor would reduce these hazards to insignificance. All other segments have, for the most part, good access to the corridors in wet weather and during winter months.

7.8. Impact on Land Use

The discussion here concerns how much of each specific type of land use (see inventory in section 6.3.3.2.) is affected by the corridor. A discussion of general impacts related to categories of land use can be found in section 6.3.3.2. The specific impacts of a corridor are discussed in this section.

7.8.1. Dillon-Ennis Segment

7.8.1.1. Alternative A-C-Q-D-L (Q-D northern route)

This route crosses two concentrations of irrigated lands: one north of Laurin in the Ruby River valley, and one in the irrigation district northeast of Dillon. Six miles of dry cropland are crossed. A scattered built-up area on the north side of Dillon also is infringed upon. The corridor comes close to the southern border of the Dillon airport. The remaining land in this corridor is grazing and/or forest land.

7.8.1.2. Alternative A-B-D

One concentration of irrigated land south of Dillon, and 1½ miles of dry cropland (east of Dillon) are crossed. Two areas of wild hayland are also transgressed. The remainder of the corridor area consists of grazing and/or forest land.

7.8.1.3. Alternative B-C

Land in this corridor is used for grazing purposes.

7.8.1.4. Alternative Q-D (southern route)

This alternative contains a concentrated area of irrigated land in the Ruby River Valley, and the historical areas of Nevada City and Alder. The remainder of the corridor is basically grazing land.

7.8.1.5. Optimum Alternative

Of all the possible corridors in this segment, the amount of irrigated and dry cropland affected would be the least in A-B-D-L, and the historical area around Nevada City would be bypassed by the largest margin.

7.8.2. Ennis-Big Sky Segment

7.8.2.1. Alternative L-K (northern route)

This alternative contains two areas of irrigated land, while the remainder is grazing and/or forest land.

7.8.2.2. Alternative L-K (southern route)

Two areas of irrigated land, one area of dry cropland, and one scattered built-up area are in this corridor. The remaining land use is related to grazing and/or forestry.

7.8.2.3. Alternative K-G (northern route)

The corridor area is included in Senate Bill 393 (see discussion in section 6.3.3.2.) and is partially a roadless area. Portions of the corridor are also classified as grazing and/or forest land. Point K is near a campground.

7.8.2.4. Alternative K-G (southern route)

The land uses in this alternative are similar to the northern route of corridor K-G.

7.8.2.5. Alternative K-J

The land uses in corridor K-J are also similar to those in alternative K-G.

7.8.2.6. Alternative J-G

This alternative differs from corridor K-G only in that it is not near any campgrounds.

7.8.2.7. Alternative L-I

This corridor contains a scattered built-up area and a small amount of irrigated land. The remainder of the corridor is grazing and/or forest land.

7.8.2.8. Alternative I-H

This alternative lies within the area designated in Senate Bill 393 and in a roadless area. Grazing and/or forest land are also included in this corridor.

7.8.2.9. Alternative H-G

This alternative is similar to I-H above.

7.8.2.10. Alternative H-F

The western portion of this corridor is included in Senate Bill 393 and is a roadless area. The remainder of the corridor is grazing and/or forest land.

7.8.2.11. Alternative F-G

This corridor consists of grazing and/or forest land.

7.8.2.12. Alternative E-I

This corridor crosses one area of irrigated land and is near one campground. The rest of the area is grazing and/or forest land.

7.8.2.13. Alternative E-F

Two areas of irrigated land, and a potential settlement area are crossed on the western half of the corridor. The eastern half runs through a state game management area and the area specified in Senate Bill 393. The remainder of the corridor is grazing and/or forest land.

7.8.2.14. Alternative D-E

Two potential settlement areas are crossed. The remaining land in the corridor is grazing and/or forest land.

All of the above alternatives listed for the Ennis-Big Sky segment which cross areas included in Senate Bill 393 and roadless areas are good locations for dispersed recreation to take place.

The corridor with the least adverse impact on land use in this segment is L-K-G, as it is the shortest alternative. All alternatives have similar impacts relating to land use considerations, making the shortest corridor the most viable.

7.8.3. Ennis-Bozeman Segment

7.8.3.1. Alternative L-M

This corridor crosses ½ to 1½ miles of irrigated land, and about ½ mile of wild hayland north of Ennis and west of Meadow Lake. Two potential settlement areas west of Meadow Lake would also be in the corridor. The remainder of the corridor consists of grazing and/or forest land.

7.8.3.2. Alternative M-N

Both the northwestern and southern routes consist of grazing land.

7.8.3.3. Alternative N-O

In the northern route, the area from point O to the Madison River is primarily dry cropland. The rest of the corridor is generally grazing land. The southern route contains some dry cropland at the point O end. Grazing land predominates in 90% of this route. The corridor crosses the mouth of Bear Trap Canyon just north of the Bear Trap primitive area, but will not be a physical hindrance to recreation.

7.8.3.4. Alternative O-R

This alternative crosses about 8-12 miles of irrigated or irrigable land directly west of Bozeman. Adjacent to the southwest of the irrigated area, the corridor crosses about 6 to 8 miles of dry cropland. Mitigating measures would have to be implemented in this section of the corridor.

7.8.3.5. Optimum Alternative

Within this segment, the least impact to land use would be through the use of alternative L-M (northwestern route) N (south route) O-R.

7.8.4. Bozeman-Trident Segment

7.8.4.1. Alternative Trident to Point P

This corridor contains some irrigated land in small parcel size and one area of wild hayland. The Missouri Heawaters State Monument is adjacent to the corridor area.

7.8.4.2. Alternative P-R

On the southwestern route, this corridor would coincide with the existing transportation corridor. The adverse impact would be minimal if the proposed corridor did not extend into the adjacent irrigated and dry cropland.

On the northeastern route, at least half of this corridor crosses dry cropland and some irrigated land. The remaining area is generally grazing land.

7.8.5. Bozeman-Clyde Park Segment

7.8.5.1. Alternative R-S (southern route) U-Y

Other than two small areas of irrigated land and a few scattered wild hayland areas, this corridor crosses grazing and/or forest land.

7.8.5.2. Alternative S-V (northern route)

This alternative contains grazing and/or forest land.

7.8.5.3. Alternative T-V

This corridor also contains only grazing and/or forest land.

7.8.5.4. Optimum Alternative

The alternative which would create the least adverse impacts in connecting the proposed line to a 230-kV substation would be the Bozeman to Clyde Park alternative R-S-(southern route)-U-V.

7.8.6. Clyde Park-Gardiner Segment

7.8.6.1. Alternative V-Z

A number of scattered wild haylands and one small area of irrigated land are contained within this corridor. The remainder of the corridor would be basic grazing and/or forest lands.

7.8.6.2. Alternative V-W

This corridor would consist primarily of grazing land.

7.8.6.3. Alternative W-Y

Circular sprinkling irrigation systems and other irrigated areas would be contained within this corridor. This corridor would have a substantial impact and should be avoided if other alternatives are available.

7.8.6.4. Alternative W-X

This corridor consists of grazing and/or forest land.

7.8.6.5. Alternative X-Z

This corridor is all grazing land except for a state historic site close to the Z end.

7.8.6.6. Alternative X-Y

The Y end of this corridor is in a potential settlement area. One archaeologic site is also in the corridor.

7.8.6.7. Alternative Y-AA

This alternative consists primarily of grazing and/or forest land. Parts of this corridor would include the Yellowstone River recreational waterway.

7.8.6.8. Alternative BB-AA

This alternative corridor is almost all grazing land.

7.8.6.9. Alternative Z-CC

Land in this alternative is used primarily for grazing. One area of wild hayland and one archaeologic site are also present in the corridor.

7.8.6.10. Alternative Z-BB-CC

Except for some small scattered areas of wild hayland, this corridor is primarily grazing land.

7.8.6.11. Alternative AA-DD

This corridor contains two small areas of irrigated land and several archaeologic sites. A small amount of land is also present for potential settlement. The rest of the corridor is basic grazing land.

7.8.6.12. Alternative CC-DD-EE

One area of irrigated land, one group of four archaeological sites, and one state historic site are present in the corridor. The remaining area in the corridor is grazing land.

7.8.6.13. Alternative EE-FF

On the western route, the corridor generally follows the present highway right-of-way. One highway rest area, one fishing access site, and the Yellowstone River state recreational waterway are in the corridor.

On the eastern route, basic grazing land with one area of wild hayland is included.

7.8.6.14. Alternative FF-GG

Six archaeologic sites, one potential settlement area, one fishing access site, one area of irrigated land, and one airport are included in this corridor. The potential impacts of this corridor could be mitigated by careful center-line location.

The corridor from Clyde Park to Gardiner with the least adverse impact on land use is V-W-X-Y-AA-BB-CC-DD-EE-(east route) FF-GG.

7.8.7. Bozeman-Big Sky Segment

The Bozeman-Big Sky segment has just one corridor alternative, RR-SS. The corridor from point RR to the entrance of the Gallatin Canyon consists of irrigated land mixed with some grazing land. The length of this section is approximately 10 miles long.

The second section of this corridor starts at the Gallatin Canyon entrance and proceeds to point SS at Big Sky. The Gallatin Canyon area is used in a wide variety of ways. This part of the corridor is an intensive recreational area, e.g., summer homes, camping, fishing, hunting, sight seeing, and picnicing. The canyon also serves as a starting point for dispersed recreation into the surrounding Gallatin National Forest and the Spanish Peaks primitive area. As the Gallatin Canyon is quite narrow in some places, the intensive recreation occurring there would make mitigating measures difficult to accomplish. There is also a large number of property owners in this area. If a Gallatin Canyon corridor were selected, the least impact would occur by upgrading the existing 69-kV line to a 161-kV line.

7.9. Impact on Aesthetics

The purpose of the aesthetics model is to ascertain those areas with a high visual impact, and to select a corridor with the least visual impact.

Six major segments connect points of the proposed transmission line project (see overlays included in the back pocket). Each major segment and its alternatives is analyzed in relation to visual impact.

Either Clyde Park or Trident will be the main power source for the Bozeman line. These two segments differ from the others because they end at different points. The other segments all have alternatives that begin at the same point and end at the same point.

The discussion on the Bozeman-Big Sky segment will include a comparison between that segment and the Ennis-Big Sky segment.

There are three ways to minimize aesthetic impacts: (1) keep the line clear of areas where the expectation not to see one is high (see discussion of expectation model presented in section 6.3.3.5.) (2) keep the line clear of areas with special visual characters (see discussion of visual character model in section 6.3.3.5.), and (3) construct the line where the least number of persons will see it (see discussion of frequency model in section 6.3.3.5.). The site-specific impacts discussed in this section are large-scale, affecting the corridor as a whole, in consideration of the three concerns listed above.

7.9.1. Dillon-Ennis Segment

The only aesthetic concern in ralation to this segment involves the frequency model referred to above. Alternative A-B-D would have fewer viewers than alternative A-C-Q-D, and alternative Q-D (north) would have fewer viewers than alternative Q-D (south).

7.9.2. Ennis-Big Sky Segment

All of the alternatives within this segment are fairly equal in potential impacts, as they all pass through an area in which expectation of not finding a transmission line is medium-high. A transmission line anywhere in the Ennis-Big Sky segment would impose a negative influence on the visual character of the area.

Since the alternatives are nearly equal in possible impact, the shortest route would cause the least impact on aesthetics because the potential to view it would be less.

7.9.3. Ennis-Bozeman Segment

Within this segment, the area just north of Bear Trap Canyon would be crossed by alternative N-O (south route). This would have adverse aesthetic effects, as visitors generally enter the Bear Trap area from the north. Adverse impacts would be compounded by the fact that the Bear Trap Canyon is within the Bear Trap primitive area, and, as such, is rated with a high expectation not to see a transmission line.

Construction of alternative N-O (south) would mean that an inviolate zone would not exist when entering the Bear Trap primitive area from the north.

7.9.4. Bozeman-Trident Segment

Because a transportation corridor already exists along Interstate 90 between Bozeman and Trident, one more transmission line would not be highly detrimental aesthetically.

7.9.5. Clyde Park-Bozeman Segment

The area between Clyde Park and Bozeman is preferable to the Bozeman-Trident segment because there would be fewer viewers.

7.9.6. Clyde Park-Gardiner Segment

The main aesthetic concern of this segment is that it includes a major recreational area. Highway 89 provides a direct route to Yellowstone Park, and the Yellowstone River is managed by the Montana Fish and Game Department as a State recreational waterway. Also, the Yellowstone River flows the full length of the Paradise Valley, between Livingston and Gardiner, and some Forest Service land is included in the area. Forest Service land, as well as a half-mile on both sides of the Yellowstone River, are areas in which expectation of not seeing a transmission line is medium-high.

In order to cause the least aesthetic impact in the Clyde Park-Gardiner segment, the corridor should be kept as far as possible from the Yellowstone River, on the west side of the Paradise Valley. The east side of the Paradise Valley should be avoided because of the view provided by the high mountain peaks. Although the Yankee Jim Canyon is an area where expectation not to see a transmission line is medium-high, it is the only one available directly into Gardiner. In addition, the sum of impacts for other environmental considerations in other alternatives may overshadow aesthetic concerns in this case, making the Yankee Jim Canyon a reasonable choice for a corridor.

7.9.7. Bozeman-Big Sky Segment (RR-SS)

The area known as the Gallatin Canyon in this segment is actually less than two miles wide over much of its length. For that reason, some mitigating measures would be difficult to follow. The Gallatin Canyon contains numerous campgrounds, fishing sites, scenic pull-offs, and summer homes. It is a direct route to Yellowstone Park and forms part of the inviolate zone that surrounds the park. The Gallatin River is a designated Blue Ribbon trout stream. About 90% of this alternative would follow a path along the river. Due to the recreational nature of the area, visual perception is obviously important in the Gallatin Canyon. People do not build summer homes where the visual appearance is not pleasing, and they do not camp in aesthetically unpleasing areas.

The Gallatin Canyon section of this segment has a medium-high expectation of not viewing a transmission line. There are also several campgrounds that are given a high rating on the expectation model. The visual frequency model gives Highway 191, through the Gallatin Canyon, a medium-high rating. The Gallatin Canyon is also in the altered landscape/natural dominance category on the visual model (see Visual Character map in section 6.3.3.2.).

A comparison is warranted between the Ennis-Big Sky segment and the Bozeman-Big segment at this point. If the cultural environment is weighted heavily, the Bozeman-Big Sky segment has greater impacts. If the natural environment is weighted heavier, the impacts would be greater in the Ennis-Big Sky segment. Cultural and natural visual impacts overlap each other, with both segments incurring potentially large impacts.

The best way to lessen or avoid adverse impacts in these two segments would be to upgrade the already present 69-kV line between Bozeman and Big Sky. The visual impact would be minimal if the line were upgraded using a single pole configuration.

CHAPTER EIGHT

Long-Term Considerations

As a society undergoes cultural and social change, trends and goals once considered desirable may be viewed differently. The proposed transmission line has become the focal point in a conflict between groups holding different values. Energy conservation policies have produced questions regarding the traditional definition of need and concern for the preservation of natural resources, and wilderness has resulted in controversies when these qualities are threatened.

Need has traditionally been interpreted by utilities as all the power their customers can use. In light of recent efforts to reduce energy consumption, need acquires a different connotation. For instance, does the electrical heating of dozens of swimming pools and thousands of second home condominiums constitute a "need" consistent with the priorities and values of society? This question is unresolved.

Among the reasons for construction of a given transmission line may be to increase reliability should part of the transmission system fail. Reliability is generally considered desirable. However, perfect reliability is impossible, as there is always the chance of failure. Increased reliability increases dependence upon electricity. The result of increased dependence and consumption, and the infrequent power outage cases may increase inconvenience and economic loss. This snowballing relationship between reliability, consumption, and the "need" for reliability creates a greater demand for transmission lines.

Officials of Big Sky have stated that lowered reliability results in economic loss in the resort and a risk to human life. The threat of economic loss is partly a function of the snowballing effect of reliability or, in this case, the expectation of reliability. One does not build an all-electric resort without expecting to have the reliability to operate the facilities. The threat to human life is a different matter. If, indeed, the threat exists, the resort owners should either decrease their dependence on electricity or provide a back-up system of supply because perfect reliability cannot be guaranteed by the power company. In situations where a power failure jeopardizes human life or public safety, such as in hospitals, airports, and communications systems, auxiliary power systems are always provided.

Arguments concerning aesthetic impacts are often made in terms of existing land use patterns. The area near Big Sky is undergoing rapid land use changes. Evaluations of the number of persons that will view the proposed transmission line if it is built in the Gallatin Canyon as opposed to the Ennis route may change dramatically during the life of the line. If the transmission line is used as a "wedge" to allow development of subdivisions west of the resort and a highway from Ennis to Big Sky, the number of persons viewing the line and the visual quality of the central Madison Range will be greatly altered.

All land use decisions, including decisions regarding the siting of transmission lines, involve the short-term and long-term commitment of natural resources. The present availability of these resources, whether renewable or non-renewable, is finite, and each of these resources must be appartitioned among a variety of uses. The fundamental difference between renewable and non-renewable resources lies in their future availability. For example, our forests, if properly managed, can continue to yield a crop of timber indefinitely.

Non-renewable resources, on the other hand, are exhaustible. Thus, the utilization of non-renewable resources, which in many cases involves an irreversible and irretrievable commitment of these resources, should be a concern in the siting of the proposed facility.

A certain amount of non-renewable resources will be committed regardless of the exact route followed by the proposed facility. Some of these, including the metals used in conductors and support structures, can be reclaimed. Others, including fossil fuels used to convert raw materials to usable form and to provide energy for construction itself, are consumed.

Wilderness land can be viewed as a non-renewable resource, at least in terms of several life spans. The extensive wild lands of North America have been reduced to much smaller portions of their former extent. Land use decisions cannot re-create wilderness, but they can destroy it. The area lying between Big Sky and the Madison Valley is in a wilderness state and the Ennis-Big Sky segment of the proposed transmission line would destroy an undetermined amount of that wilderness. However, what is deemed unimportant by certain population sectors or by this generation may be considered of prime importance by other population sectors or by subsequent generations. Even if the preservation of this particular pristine area is not of immediate value, it may be vital to the future goals of society, and any irreversible commitment of this resource must be made only after careful weighing of all alternatives.

APPENDIX

The design details necessary for calculating the electrical requirements for the following equipment are as listed below:

1. Condominiums

   The wall R factor is specified a minimum of 14. The ceiling R factor is specified a minimum of 20. Should the power rates increase in the near future, serious thought will be given to raising both of these factors 10 to 20%. The basic condominium wall construction is one hour sheetrock on the interior, 4 mil visqueen under the sheetrock, 2" x 4" studs with R 13 insulation, and one layer of sheathing on the exterior covered by one layer of siding. A typical roof construction is a "warm" roof. From the inside out, the materials on a typical condominium roof are: 2 x 6 T&G/exposed decking, covered with 4 mil visqueen which is then covered with two inches of a Celotex "Technifoam" product with an R of 16. That product is then covered with half inch plywood and a 235 pound asphalt shingle roof or a four ply built up roof with 90 pound mineral surface felt on top. All windows are specified to be one inch thermopanes. All doors are specified to be metal doors with foam filled insulation. Design temperature for all Big Sky facilities are -30° to 70° F with one (1) air change per hour.

2. Residences

   Upon the sale of a lot at Big Sky, the owner is required to meet covenants which are part of the contract of sale. Those covenants specify that three codes are to be followed for the construction of a private home on the lot. Those codes are: The National Electric Code, The Montana State Plumbing Code, and The Uniform Building Code.

3. Sewage Facilities

   The design details necessary for calculating electrical requirements for the sewage treatment plant are available from our Consulting Engineer, Morrison-Maierle, in Helena, Montana. This system is basically a lagoon system with no treatment other than aeration at the present time. Therefore, electrical consumption is minimal, except for two air blowers and one pump.

4. Swimming Pools

   The design used by most pools at Big Sky relies on electrically heated water for the pool and electrically heated antifreeze solution circulated through the deck or the floor around the pool. The electrical requirements for the floor boiler run approximately 40 watts per square foot to be heated, and the electrical requirements for the pool boiler usually run about 2 watts per gallon of water in the pool.

5. Hotels and Lodges

The design details for these buildings are similar to our condominiums, with respect to the insulation resistence on walls, ceilings, and the type of doors and windows that we use. The heating systems are a function of design and depend on the structure being built and the space to be heated. Detailed heat loss calculations are made in the case of every structure. The amount of BTUs required to furnish the proper heat plus the amount of air change required to meet the standards of The Uniform Building Code dictate the type of equipment used at Big Sky. Big Sky does not require, of any of its structures, any air conditioning or cooling equipment, except in localized, specified offices and Convention Center facilities. The only Convention Center facility at Big Sky is chilled with gravity circulated water through a large set of radiators. No electrical power is consumed in cooling this building, other than the circulating fans moving the air through the radiators which are required to meet the UBC air change requirements in any event.

6. Ski Lifts

All electrical design details for ski lifts are a function of the terrain and the number of people to be moved per hour. All details for this design are in the offices of the Consulting Engineers hired to do the work. At the present time, Big Sky has four lifts permanently installed. All four lifts have DC drive motors with SCR controlled equipment. All four lifts have auxiliary heat for personnel and equipment, and the Gondola has accessory motors in the loading and unloading areas for movement of the cabins to and from their cable. The motor characteristics for the four lifts are listed on the attached chart.

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